THE

POPULAR SCIENCE MONTHLY.

OCTOBER, 1887.

WHAT IS EVOLUTION?*

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EVERY one is familiar with the main facts connected with the development of an egg. We all know that it begins as a microscopic germ-cell, then grows into an egg, then organizes into a chick, and finally grows into a cock; and that the whole process follows some general, well-recognized law. Now, this process is evolution. It is more—it is *the* type of all evolution. It is that from which we get our idea of evolution, and without which there would be no such word. Whenever and wherever we find a process of change more or less resembling this, and following laws similar to those determining the development of an egg, we call it evolution.

Evolution as a *process* is not confined to one thing, the egg, nor as a doctrine is it confined to one department of science—biology. The process pervades the whole universe, and the doctrine concerns alike every department of science—yea, every department of human thought. It is literally one half of all science. Therefore, its truth or falseness, its acceptance or rejection, is no trifling matter, affecting only one small corner of the thought-realm. On the contrary, it affects profoundly the foundations of philosophy, and therefore the whole domain of thought. It determines the whole attitude of the mind toward Nature and God.

I have said evolution constitutes one half of all science. This may seem to some a startling proposition. I stop to make it good.

Every system of correlated parts may be studied from two points of view, which give rise to two departments of science, one of which —and the greater and more complex—is evolution. The one concerns changes within the system by action and reaction between the parts,

* From advance sheets of Professor Le Conte's work on "Evolution and its Relation to Religious Thought," in preparation by D. Appleton & Co.

producing equilibrium and stability; the other concerns the progressive movement of the system, as a whole, to higher and higher conditions—the movement of the point of equilibrium itself, by constant slight disturbance and readjustment of parts on a higher plane, with more complex inter-relations. The one concerns the laws of sustentation of the system, the other the laws of evolution. The one concerns things as they are, the other the process by which they become so. Now, Nature as a whole is such a system of correlated parts. Every department and sub-department of Nature, whether it be the solar system or the earth, or the organic kingdom, or human society, or the human body, is such a system of correlated parts, and is therefore subject to evolution. We can best make this thought clear by examples:

1. Take, then, the *human body*. This complex and beautiful system of correlated and nicely-adjusted parts may be studied in a state of maturity and equilibrium, in which all the organs and functions by action and reaction co-operate to produce perfect stability, health, and physical happiness. This study is physiology. Or else the same may be studied in a state of progressive change. Now, we perceive that the stability is never perfect—the point of equilibrium is ever moving. By the ever-changing number and relative power of the co-operating parts the equilibrium is ever being disturbed, only to be readjusted on a higher plane, with still more beautiful and complex inter-relations. This is growth, development, evolution. Its study is called embryology. 2. Take another example—*the solar system*. We may study sun, planets, and satellites in their mutual actions and reactions, co-operating to produce perfect equilibrium, stability, beautiful order, and musical harmony. This is the ideal of physical astronomy as embodied in Laplace's "Mécanique Céleste." Or we may study the same in its origin and progressive change. Now, we perceive that equilibrium and stability are never absolutely perfect, but, on the contrary, there is continual disturbance with readjustment on a higher plane—continual introduction of infinitesimal discord, only to enhance the grandeur and complexity of the harmonic relations. This is the nebular hypothesis—the theory of the development of the solar system. It is cosmogony; it is evolution. 3. Again: *society* may be studied in the mutual play of all its social functions so adjusted as to produce social equilibrium, happiness, prosperity, and good government. This is social statics. But equilibrium and stability are never perfect. Permanent social equilibrium would be social stagnation and decay. Therefore, we must study society also in its onward movement—the equilibrium ever disturbed, only to be readjusted on a higher plane with more and more complexly inter-related parts. This is dynamics—social progress. It is evolution. 4. Again: the *earth*, as a whole, may be studied in its present forms, and the mutual action of all its parts—lands and seas, mountains and valleys, rivers, gulfs, and bays, currents of air and ocean—and the manner in which all these, by action

and reaction, co-operate to produce climates and physical conditions such as we now find them. This is physical geography. Or, we may study the earth in its gradual progress toward its present condition—the changes which have taken place in all these parts, and consequent changes in climate; in a word, the gradual process of becoming what it now is. This is physical geology—it is evolution. 5. Lastly, we may study the whole *organic kingdom* in its entirety as we now find it—the mutual relation of different classes, orders, genera, and species to each other and to external conditions, and the action and reaction of these in the struggle for life—the geographical distribution of species and their relation to climate and other physical conditions, the whole constituting a complexly adjusted and permanent equilibrium. This is a science of great importance, but one not yet distinctly conceived, much less named.* Or, we may study the same in its gradual progressive approach, throughout all geological times, toward the present condition of things, by continual changes in the parts, and therefore disturbance of equilibrium and readjustment on a higher plane with more complex inter-relations. This is development of the organic kingdom. In the popular mind it is, *par excellence*, evolution.

We might multiply examples without limit. There are the same two points of view on all subjects. As already said, in the one we are concerned with things as they are; in the other, with the process by which they became so. This "law of becoming" in all things—this universal law of progressive inter-connected change—may be called the law of continuity. We all recognize the universal relation of things, gravitative or other, in space. This asserts the universal causal relation of things in *time*. This is the universal law of evolution.

But it has so happened that in the popular mind the term evolution is mostly confined to the development of the organic kingdom, or the law of continuity as applied to this department of Nature. The reason of this is that this department was the last to acknowledge the supremacy of this law; this is the domain in which the advocates of supernaturalism in the realm of Nature had made their last stand. But it is wholly unphilosophical thus to limit the term. If there be any evolution, *par excellence*, it is evolution of the individual or embryonic development. This is the clearest, the most familiar, and most easily understood, and therefore the type of evolution. We first take our idea of evolution from this form, and then extend it to other forms of continuous change following a similar law. But, since the popular mind limits the term to development of the organic kingdom, and since, moreover, this is now the battle-ground between the advocates of continuity and discontinuity—of naturalism and supernaturalism in the *realm of Nature*—what we shall say will have reference chiefly to this department, though we shall illustrate freely by reference to other forms of evolution.

* The term *chorology*, used by Haeckel, nearly covers the ground.

DEFINITION OF EVOLUTION.—Evolution is (I) continuous *progressive change*, (II) *according to certain laws*, (III) and by means of *resident forces*. It may doubtless be defined in other and perhaps better terms, but this suits our purposes best. Embryonic development is the type of evolution. It will be admitted that this definition is completely realized in this process. The change here is certainly continuously progressive; it is according to certain well-ascertained laws; it is by forces (vital forces) resident in the egg itself. Is, then, the process of change in the organic kingdom throughout geologic times like this? Does it correspond to the definition given above? Does IT also deserve the name of evolution? We shall see.

I. Every individual animal body—say man's—has become what it now is by a gradual process. Commencing as a microscopic spherule of living but apparently unorganized protoplasm, it gradually added cell to cell, tissue to tissue, organ to organ, and function to function; thus becoming more and more complex in the mutual action of its correlated parts, as it passed successively through the stages of germ, egg, embryo, and infant, to maturity. This ascending series of genetically connected stages is called the embryonic or *Ontogenic* series.*

There is another series the terms of which are coexistent, and which, therefore, is not in any sense a genetic or development series, but which it is important to mention, because to some degree similar to and illustrative of the last. Commencing with the lowest unicelled microscopic organisms, and passing up to the animal scale, *as it now exists*, we find a series of forms similar, though not identical, with the last. Here, again, we find cell added to cell, tissue to tissue, organ to organ, and function to function, the animal body becoming more and more complex in structure, in the mutual action of its correlated parts, and the mutual action with the environment, until we reach the highest complexity of structure and of internal and external relations only in the highest animals. This ascending series may be called the natural history series; or the classification or *Taxonomic series*.† The terms of this series are, of course, not genetically connected; at least, not directly so connected. In what way they are connected, and how the series comes to be similar to the last, we shall see by-and-by.

Finally, there is still a third series, the grandest and most fundamental of all, but only recently recognized, and therefore still imperfectly known. Commencing with the earliest organisms, the very dawn of life, in the very lowest rocks, and passing onward and upward through Eozoic, Palæozoic, Mesozoic, Cenozoic, to the Psychozoic or present time, we again find first the lowest forms, and then successively forms more and more complex in structure, in the interaction of correlated parts and in interaction with the environment, until we reach the most complex internal and external relations, and therefore

* *Ontos-gennao* (individual-making, or genesis of the individual).

† *Taxis, nomos* (relating to science of arrangement).

the highest structure only in the present time.* This series we will call the geological or *phylogenic* series.† According to the evolution theory, the terms of *this* series also are genetically connected. It is, therefore, an evolution series. Furthermore, it is the most fundamental of the three series, because it is the *cause* of the other two. The Ontogenic series is like it because it is a brief recapitulation, through heredity, as it were from memory, of its main points. The Taxonomic series is like it because the *rate* of advance along different lines was different in every degree, and therefore every stage of the advance is still represented in a general way among existing forms. Some of these points will be explained more fully in connection with the evidences of the truth of evolution.

It will be admitted, then, that we find *progressive change* in organic forms throughout geological times. This is the first point in the definition of evolution.

II. We have shown continuously progressive change in organic forms during the whole geologic history of the earth, similar in a general way to that observed in embryonic development. We wish now to show that the *laws of change* are similar in the two cases. What, then, are the laws of succession of organic forms in geologic times? I have been accustomed to formulate them thus: *a.* The law of differentiation; *b.* The law of progress of the whole; *c.* The law of cyclical movement.‡ We will take up these and explain them successively, and then, afterward, show that they are also the laws of embryonic development, and therefore the laws of evolution:

a. It is a most significant fact, to which attention was first strongly directed by Louis Agassiz, that the earliest representatives of any group, whether class, order, or family, were not what we would now call typical representatives of that group; but, on the contrary, they were, in a wonderful degree, connecting links; that is, that along with their distinctive classic, ordinal, or family characters they possessed also other characters which connected them closely with other classes, orders, or families, now widely distinct, without connecting links or intermediate forms. For example: The earliest vertebrates were fishes, but not typical fishes. On the contrary, they were fishes so closely conected by many characters with amphibian reptiles, that we hardly know whether to call some of them reptilian fishes, or fish-like reptiles. From these, as from a common vertebrate stem, were afterward separated, by slow changes from generation to generation, in two directions, the typical fishes and the true reptiles. So, also, to take another example, the first birds were far different from typical

* This statement is general; it will be modified hereafter.

† *Phule-gennao* (kind-making); genesis of the race.

‡ This formulation of the laws of organic succession was given by me in 1860, before I knew anything of either Darwin's or Spencer's evolution. They were my own mode of formulating Agassiz's views.

birds as we now know them. They were, on the contrary, birds so reptilian in character, that there is still some doubt whether bird-characters or reptilian characters predominate in the mixture, and therefore whether they ought to be called reptilian birds or bird-like reptiles. From this common stem, the more specialized modern reptiles branched off in one direction and typical birds in another, and intermediate forms became extinct; until, *now*, the two classes stand widely apart, without apparent genetic connection. This subject will be more fully treated hereafter, and other examples given. These two will be sufficient now to make the idea clear.

Such early forms combining the characters of two or more groups, now widely separated, were called by Agassiz *connecting* types, *combining* types, *synthetic* types, and sometimes *prophetic* types; by Dana, *comprehensive* types; and by Huxley, *generalized* types. They are most usually known now as *generalized* types, and their widely-separated outcomes *specialized* types. Thus, in general, we may say that the widely-separated groups of the present day, when traced back in geological times, approach one another more and more until they finally unite to form common stems, and these in their turn unite to form a common trunk. From such a common trunk, by successive branching and rebranching, each branch taking a different direction, and all growing wider and wider apart (differentiation), have been gradually generated all the diversified forms which we see at the present day. The last leafy ramifications—flower-bearing and fruit-bearing—of this tree of life, are the fauna and flora of the present epoch. The law might be called the law of ramification, of specialization of the parts, and diversification of the whole.

b. Many imagine that progress is the one law of evolution; in fact, that evolution and progress are coextensive and convertible terms. They imagine that in evolution the movement must be upward and onward in all parts; that degeneration is the opposite of evolution. This is far from the truth. There is, doubtless, in evolution, progress to higher and higher planes; but not along every line, nor in every part; for this would be contrary to the law of differentiation. It is only progress of the whole organic kingdom in its entirety. We can best make this clear by an illustration. A growing tree branches and again branches *in all directions*, some branches going upward, some sidewise, and some downward—anywhere, everywhere, for light and air; but the whole tree grows ever taller in its higher branches, larger in the circumference of its outstretching arms, and more diversified in structure. Even so the tree of life, by the law of differentiation, branches and rebranches continually in all directions—some branches going upward to higher planes (progress), some pushing horizontally, neither rising nor sinking, but only going farther from the generalized origin (specialization); some going downward (degeneration), anywhere, everywhere, for an unoccupied place in the economy of Nature,

but the whole tree grows ever higher in its highest parts, grander in its proportions, and more complexly diversified in its structure.

It may be well to pause here a moment to show how this mistaken identification of evolution with progress alone, without modification by the more fundamental laws of differentiation, has given rise to misconceptions in the popular and even in the scientific mind. The biologist is continually met with the question, "Do you mean to say that any one of the invertebrates, such, for instance, as a spider, may eventually, in the course of successive generations, become a vertebrate, or that a dog or a monkey is on the highway to become a man?" By no means. There is but one straight and narrow way to the highest in evolution as in all else, and few there be that have found it—in fact, probably two or three only at every step. The animals mentioned above have diverged from that way. In their ancestral history, they have missed the golden opportunity, if they ever had it. It is easy to go on in the way they have chosen, but impossible to get back on the ascending trunk-line. To compare again with the growing tree, only one straight trunk-line leads upward to the terminal bud. A branch once separated must grow its own way, if it grow at all.

Of the same nature is the mistake of some extreme evolutionists, such as Dr. Bastian and Professor Haeckel, and of nearly all anti-evolutionists, viz., that of imagining that the truth of evolution and that of spontaneous generation must stand or fall together. On the contrary, *if* life did *once* arise spontaneously from any lower forces, physical or chemical, by natural process, *the conditions necessary for so extraordinary a change could hardly be expected to occur but once in the history of the earth.* They are, therefore, *now*, not only unproducible, but unimaginable. Such golden opportunities do not recur. Evolution goes only onward. Therefore, the impossibility of the derivation of life from non-life *now*, is no more an argument against such a derivation *once*, than is the hopelessness of a worm ever becoming a vertebrate *now*, an argument against the derivative origin of vertebrates. Doubtless if life were now extinguished from the face of the earth, it could not again be rekindled by any natural process known to us; but the same is probably true of every step of evolution. If any class—for example, mammals—were now destroyed, it could not be reformed from any other class now living. It would be necessary to go back to the time and condition of the separation of this class from the reptilian stem. Therefore, the falseness of the doctrine of abiogenesis,* so far from being any argument against evolution, is exactly what a true conception of evolution and knowledge of its laws would lead us to expect.

c. The movement of evolution has ever been onward and upward, it is true, but not at a uniform rate in the whole, and especially in the parts. On the contrary, it has plainly moved in successive cycles.

* Genesis without previous life—spontaneous generation.

The tide of evolution rose ever higher and higher, without ebb, but it nevertheless came in successive waves, each higher than the preceding, and overborne by the succeeding. These successive cycles are the dynasties or reigns of Agassiz, and ages of Dana; the reign of mollusks, the reign of fishes, of reptiles, of mammals, and finally of *man*. During the early Palæozoic times (Cambrian and Silurian) there were no vertebrates.* But never in the history of the earth were mollusks of greater size, number, and variety of form than then. They were truly the rulers of these early seas. In the absence of competition of still higher animals, they had things all their own way, and therefore grew into a great monopoly of power. In the later Palæozoic (Devonian) fishes were introduced. They increased rapidly in size, number, and variety; and being of higher organization they quickly usurped the empire of the seas, while the mollusca dwindled in size and importance, and sought safety in a less conspicuous position. In the Mesozoic times, reptiles, introduced a little earlier,† finding congenial conditions and an unoccupied place above, rapidly increased in number, variety, and size, until sea and land seemed to have swarmed with them. Never before or since have reptiles existed in such numbers, in such variety of form, or assumed such huge proportions; nor have they ever since been so highly organized as then. They quickly became rulers in every realm of Nature—rulers of the sea, swimming reptiles; rulers of the land, walking reptiles; and rulers of the air, flying reptiles. In the unequal contest, fishes therefore sought safety in subordination. Meanwhile mammals were introduced in the Mesozoic, but small in size, low in type (marsupials), and by no means able to contest the empire with the great reptiles. But in the Cenozoic (Tertiary) the condition apparently becoming favorable for their development, they rapidly increased in number, size, variety, and grade of organization, and quickly overpowered the great reptiles, which almost immediately sank into the subordinate position in which we now find them, and thus found comparative safety. Finally, in the Quaternary, appeared man, contending doubtfully for a while with the great mammals, but soon (in Psychozoic) acquiring mastery through superior intelligence. The huge and dangerous mammals were destroyed and are still being destroyed; the useful animals and plants were preserved and made subservient to his wants; and all things on the face of the earth are being readjusted to the requirements of his rule. In all cases it will be observed that the rulers were such because, by reason of strength, organization, and intelligence, they were fitted to rule. There is always room at the top. To illustrate again by a growing tree: This successive culmination of higher and higher classes may be compared to

* Fishes were first introduced in the later Silurian, but became dominant in the Devonian.

† Amphibians were introduced in the Carboniferous, but true reptiles not until the Permian.

the flowering and fruiting of sucessively higher and higher branches. Each uppermost branch, under the genial heat and light of direct sunshine, received in abundance by reason of position, grew rapidly, flowered and fruited; but quickly dwindled when overshadowed by still higher branches, which in their turn, monopolized for a time the precious sunshine.

But observe, furthermore: when each ruling class declined in importance, it did not perish, but continued in a subordinate position. Thus, the whole organic kingdom became not only higher and higher in its highest forms, but also more and more complex in its structure and in the interaction of its correlated parts. The whole process and its result is roughly represented in the accompanying diagram (Fig. 1), in

FIG. 1.

which A B represents the course of geological time, and the curve, the rise, culmination, and decline of successive dominant classes.

THE ABOVE THREE LAWS are LAWS OF EVOLUTION.—These three laws we have shown are distinctly recognizable in the succession of organic forms in the geological history of the earth. They are, therefore, undoubtedly the *general laws of succession*. Are they also laws of evolution? Are they also discoverable in embryonic development, the type of evolution? They are, as we now proceed to show:

In reproduction the new individual appears: 1. As a *germ*-cell—a single microscopic living cell. 2. Then, by growth and multiplication of cells, it becomes an *egg*. This may be characterized as an aggregate of *similar* cells, and therefore is not yet differentiated into tissues and organs. In other words, it is not yet visibly organized; for organization may be defined as the possession of different parts, performing different functions, and all co-operating for one given end, viz., the life and well-being of the organism. 3. Then commences the really characteristic process of development, viz., *differentiation* or diversification. The cells are at first all alike in form and function, for all are globular in form, and each performs all the functions necessary for life. From this common point now commences development in *different directions*, which may be compared to a branching and rebranching, with more and more complex results, according as the animal is higher in the scale of organization and advances toward a state of maturity. First, the cell-aggregate (egg) separates into three distinct layers of cells, called ecto-blast, endo-blast, and meso-blast. These by further differentiation form the three fundamental groups of organs and functions, viz., the *nervous system*, the *nutritive system*, and the *blood system*: the first presiding over the exchange of *force*

or influence, by action and reaction with the environment, and between the different parts of the organism; the second presiding over the exchange of *matter* with the environment, by absorption and elimination; the third presiding over exchanges of matter between different parts of the organism. The first system of functions and organs may be compared to a system of telegraphy, foreign and domestic; the second to foreign commerce; the third to an internal carrying-trade. Following out any one of these groups in higher animals, say the nervous system, it quickly differentiates again into two sub-systems, viz., cerebro-spinal and ganglionic, each having its own distinctive functions, which we can not stop to explain. Then the cerebro-spinal again differentiates into voluntary and reflex systems. All of these have meanwhile separated into sensory and motor centers and fibers. Then, taking only the sensory fibers, these again are differentiated into five special senses, each having a wholly different function. Then, finally, taking any one of these, say the *sense of touch* or feeling, this again is differentiated into many kinds of fibers, each responding to a different impression, some to heat, others to cold, still others to pressure, etc. We have taken the nervous system; but the same differentiation and redifferentiation takes place in all other systems, and is carried to higher and higher points according to the position in the scale of the animal which is to be formed.

Or, to vary the mode of presentation a little, the cells of the original aggregate, commencing all alike, immediately begin to take on different forms in order to perform different functions. Some cells take on a certain form and aggregate themselves to form a peculiar tissue which we call muscle, and which does nothing else, can do nothing else, than contract under stimulus. Another group of cells take on another peculiar form and aggregate themselves to form another and very different tissue, viz., nervous tissue, which does nothing and can do nothing but carry influence back and forth between the great external world and the little world of consciousness within. Still another group of cells take still another form and aggregate to form still another tissue, viz., the *epithelial*, whose only function is to absorb nutritive and eliminate waste matters. Thus, by differentiation of form and limitation of function, or division of labor, the different parts of the organism are bound more and more closely together by mutual dependence, and the whole becomes more and more distinctly individuated, and separation of parts becomes more and more a mutilation, and finally becomes impossible without death. This process, as already said, reaches its highest point only in the later stages of development of the highest animals.

The *law of progress* is, of course, admitted to be a law of ontogeny; but observe here, also, it is true only of the whole and not necessarily of all the parts, *except from the point of view of the whole.* Thus, for example, starting all from a common form or generalized

type, some cells *advance* to the dignity of brain-cells, whose function is somehow connected with the generation or at least the manifestation of thought, will, and emotion; other cells *descend* to the position of kidney-cells, whose sole function is the excretion of urine. But here, also, the highest cells are successively higher, and the whole aggregate is successively nobler and more complex. It is again a branching and rebranching in every direction, some going upward, some downward, some horizontally, anywhere, everywhere, to increase the complexity of relations internal and external, and therefore to elevate the plane of the whole.

Lastly, the law of cyclical movement is also a law of ontogeny and therefore of evolution. This law, however, is less fundamental than the other two, and is, therefore, less conspicuous in the ontogenic than in the phylogenic series. It is conspicuous only in the later stages of ontogeny and in other higher kinds of evolution, such as social evolution. For example, in the ontogenic development of the body and mind from childhood to manhood we have plainly successive culminations and declines of higher and higher functions. In bodily development we have culminating first the *nutritive* functions, then the *reproductive* and *muscular*, and lastly the *cerebral*. In mental development we have culmination first of the receptive and retentive faculties in childhood, then of imaginative and æsthetic faculties in youth and young manhood; then of the reflective and elaborative faculties—the faculties of productive work in mature manhood; and, finally, the moral and religious sentiments in old age. The first gathers and stores materials; the second vivifies and makes them plastic building materials; the third uses them in actual constructive work—in building the temple of science and philosophy; and the fourth dedicates that temple only to noblest purposes.

Observe here, also, that when each group of faculties culminates and declines it does not perish, but only becomes subordinate to the next higher dominant group, and the whole psychical organism becomes not only higher and higher in its highest parts, but also more and more complex in its structure and in the interaction of its correlated parts.

Observe, again, the necessity laid upon us by this law—the necessity of continued evolution to the end. Childhood, beautiful childhood, can not remain—it must quickly pass. If, with the decline of its characteristic faculties, the next higher group characteristic of youth do not increase and become dominant, then the glory of life is already past and deterioration begins. Have we not all seen sad examples of this? Youth, glorious youth, must also pass. If the next higher group of reflective and elaborative faculties do not arise and dominate, then progressive deterioration of character commences here—thenceforward the whole nature becomes coarse, as we so often see in young men, or else shrivels and withers, as we so often see in young

women. Finally, manhood, strong and self-relying manhood, must also pass. If the moral and religious sentiments have not been slowly growing and gathering strength all along, and do not now assert their dominance over the whole man, then commences the final and saddest decline of all, and old age becomes the pitiable thing we so often see it. But, if the evolution have been normal throughout; if the highest moral and religious nature have been gathering strength through all and now dominates all, then the psychic evolution rises to the end—then the course of life is like a wave rising and cresting only at the moment of its dissolution, or, like the course of the sun, if not brightest at least most glorious in its setting. And thus—may we not hope?—the glories of the close of a well-spent life become the pledge and harbinger of an eternal to-morrow.

We have thus far illustrated the three laws of succession of organic forms by ontogeny, because this is the type of evolution; but they may be illustrated also by other forms of evolution. Next to the development of the individual, undoubtedly the *progress of society* furnishes the best illustration of these laws.

Commencing with a condition in which each individual performs all necessary social functions, but very imperfectly; in which each individual is his own shoemaker and tailor, and house-builder and farmer, and therefore all persons are socially alike; as society advances, the constituent members begin to diverge, some taking on one social function and some another, until in the highest stages of social organization this diversification or division and subdivision of labor reaches its highest point, and each member of the aggregate can do perfectly but one thing. Thus, the social organism becomes more and more strongly bound together by mutual dependence and separation becomes mutilation. I do not mean to say that this extreme is desirable, but only that an approach to this is *a* natural law of social development. *Is not this the law of differentiation?*

So also *progress* is here, as in other forms of evolution—a *progress of the whole*, but not necessarily of every part. Some members of the social aggregate advance *upward* to the dignity of statesmen, philosophers, and poets; some advance *downward* to the position of scavengers and sewer-cleaners.* But the highest members are progressively higher, and the whole aggregate is progressively grander and more complex, in structure and functions.

So, again, the *law of cyclical movement* is equally conspicuous here. Society everywhere advances, not uniformly, but by successive waves, each higher than the last; each urged by a newer and higher social force, and embodying a new and higher phase of civilization. Again: as each phase declines, its characteristic social force is not lost, but becomes incorporated into the next higher phase as a subordinate prin-

* Of course I mean downward in *social function*. Individually the scavenger may be nobler than the statesman.

ciple, and thus the social organism as a whole becomes not only higher and higher, but also more and more complex in the mutual relations of its interacting social forces.

Let us not be misunderstood, however. There is undoubtedly in social evolution something more and higher than we have described, but which does not concern us here, except to guard against misconstruction. There is in society a *voluntary progress* wholly different from the evolution we have been describing. In *true* or material evolution natural law works for the betterment of the whole utterly regardless of the elevation of the individual, and the individual contributes to the advance of the whole quite unconsciously while striving only for his own betterment. This unconscious evolution by natural law inherited from the animal kingdom is conspicuous enough in society, especially in its early stages, but we would make a great mistake if we imagined, as some do, that this is all. Besides the unconscious evolution by natural laws, *inherited from below*, there is a higher evolution, *inherited from above*, indissolubly connected with man's spiritual nature—a conscious, voluntary striving of the best members of the social aggregate for the betterment of the whole—a conscious, voluntary striving both of the individual and of society toward a recognized *ideal*. In the one kind of evolution the fittest are those most in harmony with the environment, and which therefore always survive; in the other, the fittest are those most in harmony with the ideal, and which often do not survive. The laws of this free voluntary progress are little understood. They are of supreme importance, but do not specially concern us here.

The three laws above mentioned might be illustrated equally well by all other forms of evolution. We have selected only those which are most familiar. They may, therefore, be truly called the laws of evolution. We have shown that they are the laws of succession of organic forms.

III. Thus far in our argument I suppose that most well-informed men will raise no objection. It will be admitted, I think, even by those most bitterly opposed to the theory of evolution, that there has been throughout the whole geological history of the earth an onward movement of the organic kingdom to higher and higher levels. It will be admitted, also, that there is a grand and most significant resemblance between the course of development of the organic kingdom and the course of embryonic development—between the laws of succession of organic forms and the laws of ontogenic evolution. But there is another essential element in ontogenic evolution. It is that the *forces* or causes of evolution are *natural;* that they reside in the thing developing and in the reacting environment. This we know is true of embryonic development; is it true also of the geologic succession of organic forms? It is true of ontogeny; is it true also of phylogeny? If not, then only by a metaphor can we call the process of change in

the organic kingdom throughout geological history an evolution. This is the point of discussion, and not only of discussion, but, alas! of heated and even angry dispute. The field of discussion is thus narrowed to this third point only.

Before stating the two opposite views of the cause of evolution, it is necessary to remind the reader that when the evolutionist speaks of the forces that determine progressive changes in organic forms as *resident* or *inherent*, all that he means, or ought to mean, is that they are resident in the same sense as all natural forces are resident; in the same sense that the vital forces of the embryo are resident in the embryo, or that the forces of the development of the solar system according to the nebular or any other cosmogonic hypotheses are resident in that system. In other words, they mean only that they are *natural*, not supernatural. This does not, of course, touch that deeper, that deepest of all questions, viz., the essential *nature and origin of natural forces;* how far they are independent and self-existent, and how far they are only modes of divine energy. This is a question of philosophy, not of science.

As already stated, all will admit a grand resemblance between the stages of embryonic development and those of the development of the organic kingdom. This was first brought out clearly by Louis Agassiz, and is, in fact, the greatest result of his life-work. All admit, also, that the embryonic development is a natural process. Is the development of the organic kingdom also a natural process? All biologists of the present day contend that it is; all the old-school naturalists, with Agassiz at their head, and all anti-evolutionists of every school, contend that it is not. We take Agassiz as the type of this school, because he has most fully elaborated and most distinctly formulated this view. As formulated by him, it has stood in the minds of many as an alternative and substitute for evolution.

According to the evolutionists, all organic forms, whether species, genera, families, orders, classes, etc., are variable, and, if external conditions favor, these variations accumulate in one direction and gradually produce new forms, the intermediate links being usually destroyed or dying out. According to Agassiz, the higher groups, such as genera, families, orders, etc., are indeed variable by the introduction of new species, but species are the ultimate elements of classification, and, like the ultimate elements of chemistry, are unchangeable; and, therefore, the speculations of the evolutionist concerning the transmutation of species are as vain as were the speculations of the alchemists concerning the transmutation of metals—that the origin of man, for example, from any lower species is as impossible as the origin of gold from any baser metal. Both sides admit frequent change of species during geological history, but one regards the change as a change by gradual *transmutation* of one species *into* another through successive generations and by *natural* process, the other as change by *substitution* of

one species *for* another by direct supernatural *creative act*. Both admit the gradual development of the organic kingdom as a whole through stages similar to those of embryonic development; but the one regards the whole process as natural, and therefore strictly comparable to embryonic development, the other as requiring frequent special interference of creative energy, and therefore comparable rather to the development of a building under the hand and according to the preconceived plan of an architect—a plan, in this case, conceived in eternity and carried out consistently through infinite time. It is seen that the essential point of difference is this: The one asserts the variability of species (if conditions favor, and time enough is given) without limit; the other asserts the permanency of specific forms, or their variability only within narrow limits. The one asserts the origin of species by "*descent with modifications*"; the other, the origin of species by "*special act of creation.*" The one asserts the law of continuity (i. e., that each stage is the natural outcome of the immediately preceding stage) in this, as in every other department of Nature; the other asserts that the law of continuity (i. e., of cause and effect) does not hold in this department; that the links of the chain of changes are discontinuous, the connection between them being intellectual, not physical.

So much for sharp contrasting characterization of the two views, necessary for clear understanding of much that is to follow.

SOCIAL SUSTENANCE.

By HENRY J. PHILPOTT.

IV.—ALLOTMENT OF SPECIALTIES.

THUS far we have left untouched, as nearly as possible, one vital question relating to specialties—namely: How shall they be allotted? What task shall each of us take, and to whom shall we leave this, that, and the other task which, if we do confine ourselves to one, we must leave to others? We are not concerned about personal names, but on what principles shall the allotment be made? What kind of people shall do the weaving, what kind the newspaper work, what kind the trading? Within each office, store, or factory, how shall we judge whom to select for the management, whom for the clerkships, whom for each different manual task? Passing from the monad to the mass, which community or which country shall devote its best energies to the production of which products? How shall the nations of the earth divide its work between them?

It is only in answer to this last question that, so far as I know, any economist has given any attention to the subject of allotment. It has never been elaborated, nor allowed to be the vital, rudimental question that I conceive it to be. The result is, that even those who

know the truth are constantly dropping into expressions conformable only to a false theory; just as we all speak of a "favorable balance of trade," when we know the expression conveys a wrong idea.

In regard to allotment of specialties or industries the theory which finds readiest and commonest expressions, even among those who know better, is that each task should be done by the one most capable of doing it, each industry carried on by the class, community, or country by which it can be done with the least outlay of labor and capital. By most people this is regarded as an axiom, needing no proof because admitting of no denial. They are as sure of it as their ancestors were that the sun daily revolves around the earth.

In all the hot disputes with which the free-traders and protectionists have enlivened the politics and enlightened the minds of the populace, they have rarely if ever failed to agree on the axiomatic truth of this falsehood. One wants free trade because it will secure to each industry a development in the country whose natural resources are best adapted to it. The other is able to prove, in a particular case, that his own is that country, and that therefore the Government should step in and bring about the development which somehow fails to come of its own accord. The free-trader assumes that the natural laws of trade will bring about a certain state of things which the protectionist is able to prove that they do not, but is free to confess that they would, after a few years of governmental "encouragement."

Torrence found out the true theory as applied to international trade; Ricardo enlarged upon it, and for a time secured the credit of its invention; Mill made a complicated mathematical demonstration of it; and more recent writers have been content to briefly repeat their argument, and give it the same extremely limited application. The English economists discovered that under the system of free trade their country imported things which could have been made with less capital and labor at home. In order to silence the protectionists, who had made the same discovery, they set about to find some excuse for it. In the course of the search they discovered what they conceived to be a great mathematical principle; but they were careful to explain that it applied only to international specialization, and to give the reason why it should. Capital moves freely, they said, within national bounds, but it does not freely cross them. This argument has had a surprising longevity, considering that it is not the poor countries, but the rich ones, which import the things they could produce with little effort.

In our widening field of observation, which has the further merit of lying all about us within easy reach, we shall find many after-illustrations, and a sufficient number of more satisfactory explanations of this so-called economic paradox. It is not alone, nor chiefly, in foreign trade that we must and do leave to others tasks that we can do better than they. It is, in fact, a universal and striking feature of

specialization, which everybody might have observed by looking about him. Boys and women do a great many things that men could do better. The apprentice performs a task which the journeyman could do better; the journeyman, one at which the foreman excels him. Boy or man, the better he performs his task, the sooner he leaves it to some one who can not do it so well, while he rises to something higher. We all know that this is the rule. But we also know that there are exceptions. The exceptions are not only numerous, but interesting and instructive. They will be studied in their proper place. Just now we have on hand the preliminary business of citing examples of the operation of the rule.

We find it prevailing in the army, often to the salvation of a country. The best soldier is the first to be made something more than a mere soldier. The best captain is made a colonel, the best colonel a general, the best general a commander-in-chief. The best brakemen on the railroad are made conductors, the best firemen are made engineers, the best station-agents train-dispatchers or superintendents, or something still higher and further removed from their original work. Whoever is promoted leaves to others work in which he excels them. His very excellence in a task leads to his abandonment of it.

We have to note, however, that in all these cases the new specialty he adopts is rather nearly allied to the old one that he abandons. Success in the lower implies aptitudes available in the higher. There is another class of cases in which this is either not so important or not so apparent. The successful farmer first acquires enough capital to engage in some more agreeable business. The successful wage-worker in any line first gets money to buy a farm or a store or a factory, or something else that will give him an employment, perhaps totally unlike his own, and only more congenial because he can be its master and not its underling. Let it be admitted that frugality, judgment, or what not, has helped to bring about this result. They would all have failed if he had lacked aptitude for his original work, and it is not necessary that they should equal that aptitude in force. It is only necessary that the lack of them should not squander away the rewards of the aptitude. In all this class of cases capital is a prominent feature.

The most striking case of all, in which neither promotion by merit nor acquisition of capital has much to do, is that of women. That man could do most of her work better than she can is beyond doubt, since the experience has been tried. It may still be a question whether he can do all of it better. At any rate, we daily see that he does wash, iron, scrub, churn, sew, weave, knit, spin, and even cut and fit the woman's own clothes and dress her hair with such success that without any chance of favoritism he is able to make better wages than she can in the same employment. With few if any exceptions, whatever work man leaves to woman he leaves to one less capable in it, with the same training, than he. It needs only observation, not labored argument,

to prove this. If we seem here to be contradicting something said in another place, the apparent contradiction will be fully explained farther on.

Thus far the true theory is capable of demonstration. Beyond this point we either see it or seem to see it exemplified every day. We hire a man to do a job of work which we have not time to do ourselves. How often rightly and how often wrongly we do not know, but at any rate quite often sincerely, we think to ourselves that with the same training we could have done it better. In some cases we know we could, as well as we know anything not fully tested; and in some cases we know it even by the successful result of a sufficiently thorough test.

Adding all these demonstrable and reasonable cases together, we are safe in saying that by far the larger portion of the world's work is done by those not most capable of doing it, either by means of their own aptitudes or of the natural resources with which they are surrounded. It remains to ask and answer the question, why this is so. Why should it be the rule rather than the exception, that we must leave to others work that we can do better than they? Certainly there can not be a more important economic question than this.

It is not compulsory that we shall be tedious, but it is compulsory that we shall be somewhat analytical. We are considering the relation of a man to a task. If we were asked to give a cold, intellectual opinion as to whether a certain man should wed a certain woman, we should have to inquire into the nature of the man and the nature of the woman. So in this case we have to inquire into the peculiarities of human beings on the one hand and of tasks on the other. If the analogy seems trivial, it is worth while to remember that a man's devotion to his chosen occupation has often caused an estrangement between him and his wife.

Directing our attention first to the tasks, we find that they are not all alike in importance. Humanity as a mass can better afford to have some kinds of work bungled and slurred over than others. So can the manager of an enterprise, and he is always looking out where best to reduce his force, if he finds he must reduce it somewhere. He may make a mistake in his choice of a victim, but he makes no mistake in judging that the retention of good men in some positions is more essential to his success than in others. It is not only more important that those positions should all the time be filled, but it is more important that they should be filled by men who will do their work rightly and make no mistakes. The mistakes of the office-boy are not so damaging as the mistakes of the head-clerk. The difference between a good and a bad fireman is of more consequence to the factory than the difference between a good and a bad journeyman. We can better afford to have a worthless or a bad Congressman than a worthless or a bad President. And so on, all the way round.

If tasks differ in importance as well as in the character of their operations, so men differ in their total industrial potencies as well as in their special aptitudes. A does not always excel Z in one kind of work only, he may excel him in several kinds or in all kinds. Nobody would hesitate to admit this if A were an able-bodied man and Z an idiotic weakling. In that case the essential difference between A and Z as industrial factors is plainly seen to be quantitative. There is more of A than there is of Z. As we are wont to say, there is more in him.

Now, the fact we have to recognize is, that all the way from A to Z there is a quantitative as well as a qualitative difference between the human beings who are helping one another to make a living. Because a man is weak in one way it does not follow that he is strong in another. Because he is strong in one way it does not follow that he is weak in all other ways. So one country may excel others in a great variety of resources as well as in one. No doubt we could find two countries of which one excelled the other in every capacity for the sustenance of man, and yet under the most absolute freedom trade would go on, and ought to go on, between the two countries.

Let us define our use of the term special aptitude. Let us use it with reference to the other aptitudes of the same person or country, not with reference to those of another person or country. When we say that a person has a special aptitude for a certain work, let us mean that, while he may not be good at that work, he is better at that than at anything else.

When a person is apter at one thing than another, it may be that he is really and positively apt at that thing, or the trouble may be only that he is inapt at the other. A special aptitude is entirely consistent with, and may even proceed from, a general inaptitude.

On what principles, then, shall the allotment of specialties be made?

1. The most important specialties will naturally and rightly command the services of the persons most competent in them.

2. The demands of those which, from the nature of the soil or its occupants, are most profitable, will and should be met.

3. Each person should do the work at which he can earn most, whether or not he is as capable as others in the same work, and whether or not he must leave to others work in which he is more capable than they.

4. The incapable must be allowed to bungle away at some kind of work rather than waste their time.

5. The same privilege must be accorded to those who, like most women, are prevented by circumstances from exercising even the industrial powers they have or might under other circumstances develop.

And speaking of woman, what we have said in another place of her inherited special aptitude must be taken in connection with what

we have just said of the relativity of the term aptitude. No matter how much stronger she may be morally, she is industrially weaker than man, and even in her own special aptitude, which nevertheless is a special aptitude, she is weaker. An exception may be made in regard to her care of children, so far as it is an industrial task to be included in the study of political economy; but at any rate the cooking and the children keep her at home, and, as a rule, she must either chore about the house or do nothing most of her time, leaving unsatisfied the instinct of mutual help in social sustenance, and leaving humanity that much short of its amplest possible life.

What we are striving for is that both the competent and the incompetent shall be employed and to the best advantage. The competent must therefore do the work at which he most excels the incompetent, and the incompetent must toil and sweat over a task which the competent could do better and more easily. It is the competent, the rich, the fortunate, the versatile, who leaves to others work that he could do better than they. Mediocrity sticks to one task through life. This is the rule. We promised to point out the exceptions. They are the men of one aptitude or one acquired skill highly developed, but barred by bad habits, lack of enterprise, lack of judgment, or some other similar lack, from rising to a higher and more profitable task. If that one aptitude is itself a high one, we can hardly call the man mediocre. If it is a somewhat lower one, we may say that he is a prodigy in his way. Going on down, we reach a point where we have no hesitation in saying that no attainable development of the one faculty could lift the man above the average of his fellows.

But, as a very general rule, the man who from choice leaves to another work in which the first excels the second is the one of the two who is to be most congratulated. The other is still to be congratulated, for it gives him a job. Both parties are benefited. We never think of commiserating a man, no matter how capable he may be at his work, who has a chance to earn more at no matter how different a task, leaving his former one to no matter how sad a bungler. Why should we deplore the fact that nations are able to do the same thing? The statesmen at Washington who consider it a disgrace that America should import things for whose domestic production it has plenty of skill and ample natural resources, would let the scrubbing and care of the building in which they say these things be ever so badly botched before they would take hold and do the work themselves. No doubt the least able-bodied of them could, with an hour's practice every day, soon do it better and more easily than it is done, at least that part of it that is done by women. ✗

He not only never thinks of trying it; he never feels it the slightest disgrace to let a woman do for him work that he would be ashamed to admit his inability, with a tenth of the training, to do better than she. In many cases, perhaps a majority, he could do it without any

✗ The women wouldn't object to changing places or jobs, "no doubt" with the same practice & education they could do, at least,

training if he were thoroughly in earnest. Suppose that it were proved beyond his own doubt to be so in the case of any statesman. Would he drop his work and take to the floor-cloth? Would he even spend his idle hours in that way? If a proposition to do so were made him, he would reject it on two grounds. He would not hesitate to say that it injured both himself and the woman. It would reduce his own opportunities for the enjoyment of life, and it would reduce the woman's opportunities for the sustenance of her life.

He is right. In his own case and in the domestic allotment of specialties he gets at the right principle by instinct as well as by reasoning. It is when he comes to apply the same principle to international allotment of specialties that by some strange infatuation he goes wrong. He plainly sees that when the man A leaves to the man or woman B work that he could do with less effort and higher success, both A and B are benefited. What he does not see is that in like manner when the country A leaves to the country B the prosecution of industries in which A might excel, both countries are benefited.

He is not without some excuse for his mistake. The country A always has in it some men and some capital seeking employment. Why not employ these before we generously leave to others work for which we have greater advantages than they? Why not domesticate some foreign industry which will give them work? For the same reason that a man who loses a good job waits awhile and hunts another good one, rather than tie himself to a bad one. There are always displacement and transitory idleness for a part of both the labor and capital of a country which is making progress. It may be painful for a time to the temporarily idle and displaced, but it is part of a necessary process of readjustment and replacement. Hence, it is better for all—immediately better for some, and finally better for even the temporarily displaced. This, of course, when the displacement comes as a result of progress, as in the invention of a new machine, the opening of new routes of commerce, or the better organization of industry. If it comes from the exhaustion of mines, a shortage of money, a collapse after over-speculation, or some other cause which is retrogressive rather than progressive, then, indeed, will the idle capital and labor, if given sufficient time, take up industries formerly left to other countries, and will need no government stimulation to do so. Increase of population has this natural effect. A declining or crowded country is forced into less profitable industries, taking them away from the countries where, while not so profitable, they have been the most profitable within the reach of the unfortunate inhabitants. It thus employs a part of the labor and capital thrown out of work by its decline or crowding.

The capital thrown out of work by industrial progress will, if not destroyed, soon find better work, and so will the labor, if accompanied by sufficient energy and versatility to seek it. But, so long as there

is progress, there will be a certain portion of the labor and capital of a country which will be in a state of flux. Mobility of capital and labor is, in fact, a condition of industrial evolution, just as the unstable equilibrium of matter is a condition of all evolution. It is a condition of the growth and development of the human body that part of the cells of which it is composed to-day shall be thrown out of work to-morrow.

The equanimity of our study of political economy is always disturbed by its manifest inequalities and misfortunes. We plainly see and deeply lament the inequality in the apportionment of land and capital, and vainly try to remedy it. But is there not quite as great inequality in the apportionment of industrial powers? And where is the remedy? Which of us, by taking thought, can add a cubit to his stature? Can the Government by its force, or the economist by his advice, do it for us? And if they lack the power to make us industrially equal, what else can they do for us that will make up for this lack? Is there not here the greatest of all the advantages of one human being over another?

Would not, in fact, the equality of land and capital merely emphasize the other and confessedly irremediable inequality? The drudges who make a poor living work as hard, and their work wears as painfully on their nerves, as can be said of the competent who without land or capital are able to make a good living. Are they then to be given a good living for little or unimportant work? Not until some way is found to highly reward the man who does little because he is incapable, without encouraging the capable man to do little because he is lazy.

So much for inequality. But inequality is not the only misfortune. Aside from the fact that industry is not organized to its best advantage, is it not also apparent and regretable that under any organization we are a race of sad bunglers; and that so much of the work of sustaining social life must be done by those who are bunglers even in comparison with their fellow-beings? And what is the remedy for this?

We are growing out of it, and may still grow out of it, as also out of the inequality. And this fact that most of our progress must be growth need not discourage us from doing what we see can be done to promote the progress; our doing so will constitute a part of the process of growth. But we can do it better if we recognize that another part of the process is beyond our control, if not entirely beyond our aid; for then we shall be better able to judge when we are working in the right direction, and to make our work help rather than hinder that of the overruling Power which is pushing us on to our destiny.

THE OLDEST NOBLE OF THEM ALL.

By CARL VOGT.

WE sailed out from the little port of Alleghero, on the northwest coast of Sardinia, on a clear morning, with a bright sun, light breeze, and a moderate flow of tide, to the nearest coral banks. Our fishing-apparatus consisted of a large wooden cross-drag weighted with lead, to which ropes and nets were attached, which was to be painfully hauled over the bottom of the sea at a depth of from one hundred to two hundred metres, to gather what it could catch of the life abiding in those regions. The success of the operation depends largely on the skill and discrimination of the padrone. Two sailors and a youth manage the very primitive capstan by which the rope, that the padrone holds in his hand, is unrolled. He knows, by feeling the movements of the rope, its tension, sliding, and jerking, whether the drag is passing over sand, mud, hard ground, or solid, jagged rock. At times the youth stands alone at the capstan, and the sailors take the rudder in hand and turn the vessel as the padrone directs. Sometimes they have to work with all their might, as when the apparatus gets fastened or is drawn under overhanging rocks. There are a thousand accidents to be guarded against, and they frequently end in the loss of the drag.

Thus the sea-bottom is swept for a few hours as with a broom. The cords of the drag sling themselves around everything that projects and is movable ; large pieces of rock are ensnared and torn loose with all that is upon them. Whatever creeps upon the ground is made fast.

The padrone orders a halt, and the sailors apply themselves to the capstan to draw in the rope. It is a task calling for the exertion of their full strength to dislodge the apparatus and pull it up with the heavy load which it has collected. Sometimes the leverage of the sea-waves is invoked. The capstan is locked, the rope is stretched to its utmost, and the bark is set by a few motions of the rudder upon the crest of a rising wave. The reaction, when the machine is dislodged, is often so strong as to threaten to overturn the bark. A cloud of slime announces the approach of the apparatus to the surface. The drag is pulled out and laid upon the ship's edge, and the nets which are swimming around are drawn in and thrown into the inner space. Capstan and helm are deserted, and the sail is drawn in. The men squat in a ring around the net, and pick out with their fingers the objects that are entangled in it, and sometimes the knife has to be used to solve some unusual complication. I had filled my pail with clear sea-water before the apparatus was drawn up. I had given orders, which were very difficult to get executed, to have nothing cast

overboard, so great was the temptation to the men to judge this or that piece of coral worthless and throw it away. After taking a lunch, I took out my instruments which I had provided for the occasion, and made a careful examination of the stones, to see what life might be upon them, scrutinizing every cavity and crevice closely with the lens. At last I found the particular object of which I was in search. It was a little shell about the size and thickness of a lentil, which had grown fast to the stone by a piece of its edge. It was of a dingy, brownish color, with a dim red spot in the middle, and was so covered with slime and mud that it could hardly be distinguished from a stone-splinter. I loosened it with a knife and exhibited it to the boatmen on the palm of my hand. "Look at it sharply," I said, "so that you will be able to recognize it anywhere, and then help me to look for more." In the course of half an hour every stone had been examined, and three or four shells had been obtained, among them a larger one, yellowish-green and three-cornered, which was attached by the tip. "Your Excellency," said one of the sailors, "are there no such shells in the country you came from?" "In Switzerland?" I replied. "No. These shells grow only in the sea, and there is no sea in Switzerland." "That is a good way from here, and the journey must have cost a great deal of money. We are very simple people, your Excellency, and must believe you; but we can not understand why you should have come so far and spent so much money just to get two or three poor little shells that are not worth any money." "But I tell you it is worth a great deal to me to see these shells living." "But you can't sell the shells and get your money back again?" "Certainly not, but I have another kind of interest in them." "We believe, indeed, that something else must be hidden behind this, and that is what we should like to know; but it does not concern us any further. We give you the shells because you have paid us for them, and wash our hands in innocence. You are responsible for what else is done with them; but a prudent man does not act as you do. Don't consider it wrong in us, your Excellency. We should like to earn enough in this business to devote a candle to the Madonna of Valverde, with which we may atone for our sins, and the Madonna will pardon us if we have helped on a little foolery or witchcraft to earn a little money by it."

It had come to this, then, that I was a fool or a wizard. I should clearly have to give some explanation of my business to these men; but it would be impossible to make their simple heads take the conception of science or of scientific interest. So I was obliged to make up a little fiction or allegory with which to put them off, and I told them that I wanted the shells to settle a wager. I had been present at a discussion, I said, a long time ago, in the company of Prince Humbert (now king), as to which were the oldest noble families on the earth. Some were of the opinion that they were to be found in this nation and some in that, when I interfered and said that I knew of a

much older nobility than any that they had brought forward—of one that was present at the creation of the world. The crown-prince, intimating that my mere assertion could not carry the day, invited me to produce a living shoot of that old stock. I told him that I would do so if I were given time, and he granted me as long an indulgence as I desired. Some years had passed since my promise was made; but now I desired to fulfill it, and had come to this place to get the living shoots of the oldest family on the earth. What I had asserted was the simple truth. The ancestors of these shells have lived in the sea ever since there was a sea, "and now I shall take these living muscles to the king and tell him that I have won the bet."

Let us look now at the little company which is collected here on a stone, and whose individual members are found in the Mediterranean Sea. The largest of the specimens on the right side of the drawing,

FIG. 1.—MEMBERS OF THE OLDEST FAMILY.

which has grown by a short stalk to a small coral-stem, represents a smooth shell, of glassy clearness, and hard as glass. Linnæus was acquainted with it, and called it *Terebratula vitrea*, or the glassy terebratula. Another much smaller kind, whose white, three-cornered shells are neatly furrowed in the direction of their length, is supposed to have a kind of resemblance which I have never been able to find, with a snake's head, and is named in the classification *Terebratulina caput serpentis*. Two specimens can be seen in the drawing, one in the right-hand lower corner of the stone, on the surface; the other on top near the middle, in profile. On the Sardinian coast this species wears a yellowish-green coat, which consists of a slime sticking fast to the shell with sand-grains. I thought at first that I had discovered a new species, and would be able to perpetuate my name in the zoölogical registers till the end of science, by giving it to this creature, when my zeal unluckily prompted me to take hold of the soft coat with a pincers. The tool drew off the envelope and under it shone the ivory-white shell. Besides these two species belonging to the

family of the *Terebratulæ*, there are two smaller shells on the stone. The smallest species, of which three specimens lie on the middle of the stone, has the form of a heart, which is attached by its point. It shows a few dull-red spots on the middle of the shell, and is named *Argiope*. The other one, a little larger species, appears at the left in three specimens, with a straight hinge-border, and is broad and firm, and is called *Megerlea*.

We placed this piece of stone with its four species of shells, to which others that abound in the Mediterranean might be added, into a pail filled with sea-water, in which several other animals were stirring. We intended to watch the life-expressions of these fixed animals. Our patience was exposed to a hard trial. Hours passed away, without our being able to perceive the slightest movement. We had become tired and were yawning, when we thought we perceived the little *Argiope* mocking us. It was, in fact, gaping. The *Megerlea*, the snake-head terebratula, and the glass terebratula, followed its example and yawned too, but as discreetly as if they were in well-bred society. The valves parted from one another only a little; a few fine, glassy, glistening hairs, which could only be seen with the glass, appeared outside. That was all. Terebratulas have been kept for weeks and months living in glass vessels filled with sea-water, without any other movement being perceived than this gaping, which sometimes continued for hours. When they had gaped enough, they shut their shells, slowly and measuredly, as if they would sleep; and, when they had slept enough, they gaped again. Old noble by entail, which has grown fast to its estate, and sleeps or gaps its life away! But what do they feed upon? A closer investigation was required to find that out.

The two valves of the shell are not alike. The difference is greatest in the terebratula. One valve is wide, bellied, and runs into an upward-turned beak perforated by a round hole through which passes a short, round stem that is resolved outside of the shell into a bundle of thongs by which the animal fastens itself. The smaller valve rests as a cover upon this one.

We try to open the valves as they are opened in the gaping, but it is impossible to do it without force; so we have to break the shell open. Fig. 2 shows the opened snake-head terebratula magnified six times. The bellied valve is filled with two peculiar, half-moon-shaped processes, consisting of two bent, cartilaginous pipes, on the outer side of which stand a number of fringes which wind in a worm-fashion and circulate in constant movement. The space between these great arms, as they are called, includes two smaller arms, provided with similar fringes, which roll up helicoidally toward the bottom. Nearly all the space of the bellied shell is occupied by these forms; except that above, toward the point of the valve, may be seen some muscles, which open and shut the shell, and conceal from view the

very small body proper. In this may be found a short bowel with a large liver, the nervous system, and, perhaps, also the heart. The bowel has a real mouth only at the junction of the two arms, but is entirely closed at the other end. The inner surface of the valve is covered with a fine, transparent skin, which is called the mantle, in the somewhat thickened border of which are planted the stiff, transparent bristles, which are moved back and forth by the contraction of the membrane in which they are fixed. The organs of generation also lie in the mantle, and are shown in the drawing as two lumps in the raised back valve. Thus, small is the body in proportion to the vigorously developed arms, from which the name of the whole class, *brachiopods*, is derived. But are they really arms? They are hardly movable. If we stick a needle into one of them, it does not stir; and there are species in which they are completely calcified. Only the fringes move and respond immediately to excitations.

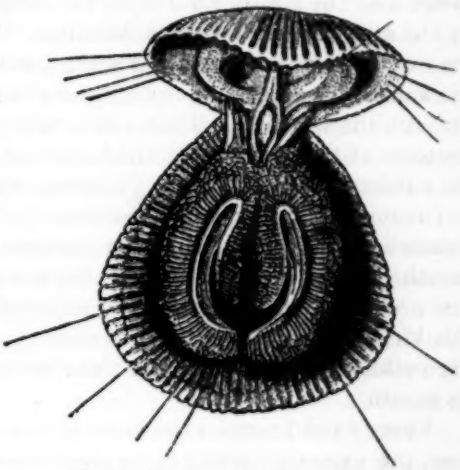


FIG. 2.—ANATOMY OF A BRACHIOPOD.

We cut off a piece of the arm and place it under the microscope. Each fringelet is a tube made of a firm, elastic membrane, in the hollow of which are laid one or two bundles of fibers of a muscular or nervous character. On the outside the tubes are clothed with delicate cells connected into a texture bearing fine, actively vibrating ciliæ. These ciliæ generate a bubbling stream in which dance the minute bodies that are floating in the sea-water. The whole stream, which the ciliæ of the thousands and thousands of tubes produce, flows from the periphery toward the mouth. The little tubes all open into the chief pipe of the arm, and are, like that vessel, filled with fluid.

With this observation a considerable number of functions are explained at the same time. The fluid in the little tubes and the chief pipe doubtless plays a part in the movements, in that it is at times pressed into the smaller vessels and expands them, and at other times is held back by the foldings and contractions brought about by the muscles in the chief pipe of the arm. But the constant stream which the ciliæ keep up is all the time bringing new particles of water, heavily charged with oxygen, in contact with the inner surface of the mantle. An exchange of gases through their thin walls is certain to arise; the stream also produces a respiration, which is simply an exchange of the carbonic acid generated within the tissues of the body for the

oxygen that is held in the water. The stream also whirls minute bodies, microscopic animals and plants, to the mouth, which swallows them. Our terebratula has no other means of getting food. As the oyster and the rotifer are fed by the streams and whirlpools produced by the ciliæ, so also is the terebratula. When the shell is closed, only the exchange of gases takes place; but when it is opened, or when the animal is gaping, it is eating, for these larger bodies are drawn in through the whirling. That this really takes place is shown by the contents of the stomach, in which we may observe undigested remains, the silicious shells of plants, diatoms, or *Radiolariæ*, and the needles of fungoids. The organic substance is digested and dissolved in the stomach, while the undigested remains are expelled through the mouth. Sea-water, especially near the ground, to which the terebratulæ are attached, swarms with shell-protected and naked matter of this kind. The terebratula is, moreover, in the happy situation of having nothing to do but spit out the shells, for the meat itself flies into its mouth.

Every fixed animal produces moving young. Were this not the case, the animals could not be distributed into spaces beyond their immediate abode. Very curious young are produced from the eggs of our arm-foots, which do not at first resemble their parents at all; larvæ that swim around in freedom, having eyes, and armed with bristles. They so much resemble the larvæ of some of the ringed worms, that one would be apt to suppose at first sight that they were of that kind. But after a time of wandering they settle themselves down, and there then takes place, with the formation of the shell, a retrograde metamorphosis, by which the animal is gradually brought back to its definite form. It is therefore easy to conceive that our arm-foot leads a very safe life, and that, protected as much as possible against enemies and other dangers, it can spin out its existence as long as the sea does not dry up. Of course, in their younger days, the wandering larvæ may be swallowed up in numbers by other animals, but when the young brachiopod is once fixed, the shell, the mantle-edge with its bristles, and the ciliary apparatus protect it so well, that not even parasites can attack it. Although fungoids, other animals, and occasionally fellow-beings of its own race may establish themselves on the outside of its shell, and load it to a certain extent, but otherwise do it no harm, no parasite has ever been seen within. The little wart that appears on the glass terebratula in the picture is one of their young. There have always been fishes which, after a fashion, eat corals and crush them with their hard teeth, to digest the polyps which the corals contain, and expel the lime-substance; but I hardly think they would take in the arm-foots, whose bodily substance is so stringy and yields so little nourishment. In the deep sea, also, the animals are thoroughly protected against the sudden changes of temperature which animals living in shallow waters and near the shores have to encounter.

I now come to my oldest noble. It is an established fact that in the most ancient strata in which fossil remains have been found, in the system called Cambrian, in the primordial fauna, shells occur which differ but little from the living arm-foots of to-day. These older or palæozoic strata fairly swarm with arm-foots; many rocks are entirely made up of them, and the richness of their forms is inexhaustible. From these earliest ages on, the animal creation gradually assumed more definite shape as the number of individual arm-foots diminished. Doubtless the more perfectly-formed organism superseded the others in the struggle for existence. The noble who relies for the support of his position only on the age of his race-stock, must die out at last if he can not adapt himself by a further development to the demands of the new time. This the arm-foots could not do: they show no progress toward a higher stage of organization. The comparatively rare brachiopods of our seas are therefore only the scanty relics of departed glory, isolated survivals of a type that was formerly wide-spread and numerous in all the seas. But it is wonderful that a race-shape should have maintained itself quite unchanged through all the geological epochs to our own time!

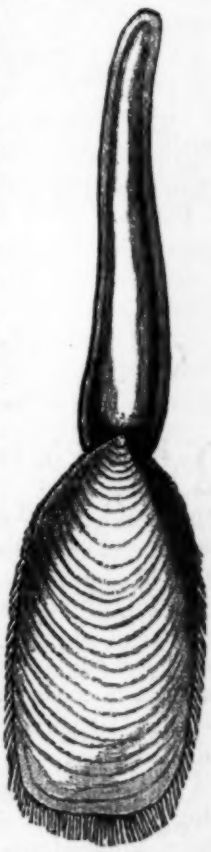


Fig. 3.—The Lingula.

At shallow places in southern seas, there creep a kind of brachiopods in the sand whose shaping is rather like that of a worm than of a brachiopod. It is called the *Lingula*, or *tongue-mussel* (Fig. 3.). This creature has an even, somewhat horny shell, and a relatively long and thick stem which is clothed within by a tough layer of muscle. Along with the other species of its kind, it is distinguished from the rest of the family by the shell having no closure, while the bowel, after many turns within the body, opens without. As the valves of the shell only cover the animal, but are not closed tight, they can be easily opened and also moved sidewise upon one another. The animal is never fixed. This is the oldest animal form of the present existing creation. Lingula-shells appear in the Cambrian strata, and have been found in all the geological systems. So far as it is possible to judge from the shells, the genus has propagated itself unchanged through all the earth-history of organisms, has survived all revolutions, and has only varied into a few species differing but little from one another.

In the Silurian strata immediately following these, in which so far nearly two thousand species of arm-foots have been found, are two other still living genera: the one, *Discinisca*, without closure, but

furnished with a muscular stalk; the other, *Rhynconella*, having a shell-closure and a fibrous, but not further contractible, stem. Most of the genera living to-day can boast of a high age. *Terebratula* traces its race-stock back to the Devonian system, as does also *Crania*, while *Argiope*, *Megerlea*, and *Terebratulina* derive their ancestors from the Jurassic.

Our oldest vertebrate is a rare fish called *Ceratodus*, which lives in some of the Australian rivers. It has a few relatives living in the rivers and marshes of Central Africa and South America, and is adapted to breathe in the air through lungs and in the water through gills. Teeth of species of *Ceratodus*, clearly recognizable by their peculiar formation, appear in the muschelkalk of Würtemberg and Central Europe. Old as the race of the *Ceratodus* may be, it can not compare with that of the primeval genus *Lingula*.

I told my coral-fishers a falsehood in my story of the bet, but, as in every fiction there is a grain of truth, there is in this one the fact of the existence, in the present animal world, of a family of extremely anciently descended nobles, whose ancestors were members of the first animal creation visible to our eyes.—*Translated for the Popular Science Monthly from Ueber Land und Meer.*

STRANGE MEDICINES.

By Miss C. F. GORDON CUMMING.

QUICKLY—by far too quickly for the sake of the student and the archæologist—is the wave of foreign influence over-sweeping Japan, ruthlessly effacing all the most marked characteristics of native manners and customs, and substituting the commonplaces of every-day European life.

Already this tendency to exalt and to adopt foreign novelties meets the traveler at every turn, and only he who turns aside from the tracks most subject to foreign influence can hope now and then to find some stanch conservative who, in that nation of ultra-radicals (albeit most loyal imperialists), has the courage to adhere to his own old-fashioned ways.

I had the good fortune to meet with such a one in the very interesting old city of Osaka—a compounder of just such strange medicines as were administered to our British ancestors in the middle ages. So rapidly has the scientific study of medicine been taken up by the Japanese medical practitioners, that the survival of such a chemist of the pure and unadulterated old school is quite remarkable; and I was greatly struck by the evident annoyance of a Japanese gentleman to whom I expressed my interest in this mediæval chemist, and who

evidently felt it humiliating that a foreigner should have seen such a relic of the days of ignorance.

The quaint old man whose loyal adherence to the customs of his ancestors afforded me such an interesting illustration both of old Japan and old Britain was a seller of *curoyakie*—i. e., carbonized animals; in other words, animals reduced to charcoal, and potted in small covered jars of earthenware, to be sold as medicine for the sick and suffering. Formerly all these animals were kept alive in the back premises, and customers selected the creature for themselves, and stood by to see it killed and burned on the spot, so that there could be no deception, and no doubt as to the freshness of their charred medicine. Doubtless some insensible foreign influence may account for the disappearance of the menagerie of waiting victims and their cremation-ground; now the zoölogical back-yard has vanished, and only the strange chemist's shop remains, like a well-stored museum, wherein are ranged portions of the dried carcasses of dogs and deer, foxes and badgers, rats and mice, toads and frogs, tigers and elephants.

The rarer the animal, and the farther it has traveled, the more precious apparently are its virtues. From the roof hung festoons of gigantic snake-skins, which certainly were foreign importations from some land where pythons flourish, Japan being happily exempt from the presence of such beautiful monsters. I saw one very fine piece of a skin, which, though badly dried and much shrunken, measured twenty-six inches across, but it was only a fragment ten feet in length, and was being gradually consumed, inch by inch, to lend mystic virtue to compounds of many strange ingredients. I was told that the perfect skin must have measured very nearly fifty feet in length. I saw another fragment twenty-two feet long and twelve inches wide; this also had evidently shrunk considerably in drying, and must, when in life, have been a very fine specimen.

There were also some very fine deer's horns (hartshorn in its pure and simple form), a highly valued rhinoceros-horn, and ivory of various animals. My companion was much tempted by a beautiful piece of ivory about ten feet in length. I think it was the horn of a narwhal, but the druggist would only sell it for its price as medicine, namely, ten cents for fifty-eight grains, whence we inferred that the druggists of Old Japan, like some nearer home, fully understand the art of making a handsome profit on their sales. Some tigers' claws and teeth were also esteemed very precious, and some strips of tigers' skin and fragments of other skins and furs proved that these also held a place in the pharmacopœia of Old Japan, as they continue to do in China (the source whence Japan derived many branches of learning, besides the use of letters).

Unfortunately for the little lizards which dart about so joyously in the sunlight, they too are classed among the popular remedies, being considered an efficacious vermifuge; so strings of their ghastly

little corpses are hung in festoons in many village shops, where I have often looked wonderingly at them, marveling in what broth of abominable things they might reappear. So lizards and dried scorpions (imported as medicine) also found a place in this strange druggist's shop—an "interior" so wholly unlike anything I have ever seen elsewhere, that the recollection of it remains vividly stamped on my memory—the multitude of earthenware jars containing the calcined animals all neatly ranged on shelves, the general litter of oddities of various sorts strongly resembling an old curiosity-shop, and, in the midst of all, the eccentric old man, who might have passed for a Japanese wizard rather than a grave physician. It was a strangely vivid illustration of what must have been the general appearance of the laboratory of the learned leeches of Britain in the days of our forefathers.

Before glancing at these, however, it may be interesting to note a few details of kindred medicine-lore in China, on which subject a member of the French Catholic mission, writing from Mongolia, says: "May Heaven preserve us from falling ill here! It is impossible to conceive who can have devised remedies so horrible as those in use in the Chinese pharmacopœia; such as drugs compounded of toads' paws, wolves' eyes, vultures' claws, human skin and fat, and other medicaments still more horrible, of which I spare you the recital. Never did witch's den contain a collection of similar horrors."

Mr. Mitford has told us how, also at Peking, he saw a Chinese physician prescribe a decoction of three scorpions for a child struck down with fever; and Mr. Gill, in his "River of Golden Sand," mentions having met a number of coolies laden with red deer's horns, some of them very fine twelve-tine antlers. They are only hunted when in velvet, and from the horns in this state a medicine is made which is one of the most highly prized in the Chinese pharmacopœia.

With regard to the singular virtues supposed to attach to the medicinal use of tiger, General Robert Warden tells me that on one occasion when, in India, he was exhibiting some trophies of the chase, some Chinamen who were present became much excited at the sight of an unusually fine tiger-skin. They eagerly inquired whether it would be possible to find the place where the carcass had been buried, because, from the bones of tigers dug up three months after burial, a decoction may be prepared which gives immense muscular power to the fortunate man who swallows it!

I am indebted to the same informant for an interesting note on the medicine folk-lore of India, namely, that while camping in the jungle, one of his men came to entreat him to shoot a night-jar for his benefit, because from the bright, prominent eyes of this bird of night an ointment is prepared which gives great clearness of vision, and is therefore highly prized.

Miss Bird, too, has recorded some very remarkable details on the

materia medica of China and Japan. When in a remote district of Japan, she became so unwell as to deem it necessary to consult a native doctor, of whom she says :

> He has great faith in *ginseng* and in rhinoceros-horn, and in the powdered liver of some animal, which, from the description, I understood to be a tiger—all specifics of the Chinese school of medicines. Dr. Nosoki showed me a small box of "unicorn's" horn, which he said was worth more than its weight in gold.

She adds :

> Afterward, in China, I heard much more of the miraculous virtues of these drugs, and in Salangor, in the Malay Peninsula, I saw a most amusing scene after the death of a tiger. A number of Chinese flew upon the body, cut out the liver, eyes, and spleen, and carefully drained every drop of the blood, fighting for the possession of things so precious, while those who were not so fortunate as to secure any of these cut out the cartilage from the joints. The center of a tiger's eyeball is supposed to possess nearly miraculous virtues; the blood, dried at a temperature of 110°, is the strongest of all tonics, and gives strength and courage, and the powdered liver and spleen are good for many diseases, . . . and were sold at high prices to Chinese doctors. A little later, in Perak, I saw rhinoceros-horns sold at a high price for the Chinese drug-market, and was told that a single horn with a particular mark on it was worth fifty dollars for sale to the Chinese doctors.

One of the said rhinoceros-horns was, as we have seen, among the most valued treasures of the old druggist of Osaka. This horn and that of the unicorn (which seems generally to mean the narwhal*) have ever been held in high repute throughout the East as an antidote to poison, and cups carved from these horns were used as a safeguard because they possessed the property of neutralizing poison, or at least of revealing its presence.

And indeed the same virtue was attributed to it by the learned leeches of Europe. At the close of the sixteenth century the doctors of medicine in Augsburg met in solemn conclave to examiae n specimen of unicorn's horn, which they found to be true *monoceros*, and not a forgery ; the proof thereof being that they administered some of it to a dog which had been poisoned with arsenic, and which recovered after swallowing the antidote. They further administered *nux-vomica* to two dogs, and to one they gave twelve grains of unicorn-horn, which effectually counteracted the poison ; but the other poor dog got none, so he died. Similar statements concerning this antidote, and also concerning the value of elks' and deer's horns powdered as a cure for epilepsy, appear in various old English medical works of the highest authority.

Very remarkable, also, is the efficacy supposed to attach to antediluvian ivory, more especially the tusks of the mammoths, which have been so well preserved in Siberian ice that their very flesh is

* *Monodon monoceros.*

still sometimes found untainted. There they have lain hermetically sealed for many a long century, and now, when the rivers from time to time wash away fragments of the great ice-cliffs, they reveal the strange treasures of that wondrous storehouse — sometimes a huge unwieldy hippopotamus, or a rhinoceros, or it may be a great woolly elephant with a mane like a lion and curly tusks; and the hungry Siberian bears and wolves fight and snarl over these dainty morsels, which are still as fresh as though they had fallen but an hour ago.

Here, in these marvelous ice-fields, lie inexhaustible stores of finest ivory, and this it is which the learned professors of the Celestial medical hall value so highly. So these precious tusks are dragged forth after thousands of years, to be ground down and boiled to a jelly for the cure of vulgar Chinese diseases of the nineteenth century! Alas, poor mammoth!

Nor are these the only antediluvian relics which are thus turned to account. Professor H. N. Moseley tells us of the "dragon's teeth and bones" which he bought from the druggists of Canton, where they are sold by weight as a regular medicine, and are highly prized in the materia medica both of China and Japan as specifics in certain diseases. They proved on examination to be the fossil teeth and bones of various extinct mammalia of the Tertiary period, including those of the rhinoceros, elephant, horse, mastodon, stag, hippotherium, and the teeth of another carnivorous animal unknown.

He obtained a translation of the passage in the medical works of Li She Chan which specially refers to the use of this medicine. It states that "dragons' bones come from the southern parts of Shansi, and are found in the mountains." Dr. To Wang King says that if they are genuine they will adhere to the tongue. "This medicine is sweet and is not poison. Dr. Koon certainly says that it is a little poisonous. Care must be taken not to let it come in contact with fish or iron. It cures heart-ache, stomach-ache, drives away ghosts, cures colds and dysentery, irregularities of the digestive organs, paralysis, etc., and increases the general health."

Another medical authority, "The Chinese Repository," published in Canton A. D. 1832, states that the bones of dragons are found on banks of rivers and in caves of the earth, places where the dragon died. Those of the back and brain are highly prized, being variegated with different streaks on a white ground. The best are known by slipping the tongue lightly over them. The teeth are of little firmness. The horns are hard and strong; but if these are taken from damp places, or by women, they are worthless.

From his examination of these so-called relics of the dragon (which prove to belong to so many different animals, which in successive ages have crept to the same cave to die), Mr. Moseley points out how some imaginative person probably first devised a fanciful picture of the mythical animal, combining the body of the vast lizard with the wings

of a bat, the head of a stag, and carnivorous teeth, which has become the stereotyped idea of the dragon in all lands.

Even in Europe fossil bones thus found together in caves were long known as dragons' bones, and accounted useful in medicine. Indeed, so great was the demand for these and similar relics, that our museums and scientific men have good cause to rejoice that their ancestors failed to discover what stores of old bones lay hidden in our own seaboard caves—as, for instance, in that wonderful Kirkdale cavern, where the mortal remains of several hundred hyenas were found, guarding the teeth of a baby mammoth, a patriarchal tiger, a rhinoceros, and a hippopotamus; or the caves along the Norfolk coast, where Hugh Miller tells us that within thirteen years the oyster-dredgers dragged up the tusks and grinders of five hundred mammoths; or those wonderful zoölogical cemeteries where the fossil bones of cave-lions, cave-hyenas, elephants, mammoths, hippopotami, woolly rhinoceros, red deer and fallow deer, oxen, sheep, and horses, have lain so securely, stored for untold ages beneath Charing Cross and Trafalgar Square.

After all, this reduction of prehistoric bones and ivory to vulgar powders for medicinal use is not more strange than the fossil food which forms so large a part of the daily bread of multitudes of our fellow-creatures in Lapland, Finland, and Sweden, in Carolina and Florida, on the banks of the Orinoco and of the Amazon, where vast tracts of earth are found composed wholly of myriads of microscopic shells, and this strange mountain-meal, being duly mixed with meal of the nineteenth century, is freely eaten by the people. In Lapland alone, hundreds of wagon-loads are annually dug from one great field, and there are men who eat as much as a pound and a half per diem of this curious condiment. We hear of fields, as yet untouched, having been discovered in Bohemia, Hungary, and other parts of Europe; so perhaps we may ere long add these primeval atoms to the delicacies of our own tables.

Of the firm belief of the Chinese in the efficacy of medicines compounded of the eyes and vitals of the human body we have had too terrible proof; for it is well known that one cause which led to the appalling Tientsin massacre in 1870 was the wide-spread rumor that the foreign doctors (whose skill all were forced to admit) obtained their medicines by kidnapping and murdering Chinese children and tearing out their hearts and eyes! As this nice prescription is actually described in their own books as a potent medicine, the story obtained ready credence, and we all remember the result. Moreover, the same accusation has repeatedly been spread on other occasions of popular excitement against foreign teachers.

I am not certain whether the Lamas of Peking have there introduced the fashion of administering medicine from a drinking-cup fashioned from the upper part of a wise man's skull; but

such medicine-cups are greatly esteemed in Thibet, where they are mounted in gold, silver, or copper.

Such details as all these are apt to sound to us strangely unreal as we read them somewhat in the light of travelers' tales, with reference to far-away lands; but it certainly is startling when, for the first time, we realize how exactly descriptive they are of the medicine-lore of our own ancestors—in truth, to this day we may find among ourselves some survivals of the old superstitions still lingering in out-of-the-way corners. Thus it is only a few years since the skull of a suicide was used in Caithness as a drinking-cup for the cure of epilepsy. Dr. Arthur Mitchell knows of a case in which the body of such a one was disinterred in order to obtain her skull for this purpose.

It was, however, accounted a more sure specific for epilepsy to reduce part of the skull to powder and swallow it. Even the moss which grew on such skulls was deemed a certain cure for various diseases. Nor was this simply a popular superstition. In the official Pharmacopœia of the College of Physicians of London, A. D. 1678, *the skull of a man who has died a violent death*, and the horn of a unicorn, appear as highly approved medicines. Again, in 1724, the same pharmacopœia mentions unicorn's horn, human fat, and *human skulls*, dog's dung, toads, vipers, and worms, among the really valuable medical stores. The pharmacopœia was revised in 1742, and various ingredients were rejected, but centipeds, vipers, and lizards were retained.

Nor were these strange compounds prepared for human subjects only. In the "Angler's Vade Mecum," published in 1681, anglers are recommended to use an ointment for the luring of fish, consisting, among other horrible ingredients, of *man's fat*, cat's fat, heron's fat, asafœtida, finely powdered mummy, camphor, oil of lavender, etc.; and it was added that man's fat could be obtained from the London chirurgeons concerned in anatomy.

Of ordinary skulls, multitudes are known to have been exported from Ireland to Germany for the manufacture of a famous ointment. But as regards the more precious skull of the sinner who has died by his own hand, some faith in its efficacy seems still to linger in various parts of Britain. The Rev. T. F. Thiselton Dyer quotes an instance of it in England in 1858; and some years later, a collier's wife applied to the sexton at Ruabon in Wales for a fragment of a human skull, which she purposed grating to a fine powder, to be mixed with other ingredients as a medicine for her daughter, who suffered from fits. Scotland likewise furnishes a recent instance of the same strange faith, which about thirty years ago happened to come under the notice of Sir James Simpson, in the parish of Nigg in Ross-shire, where, a lad having been attacked with epilepsy, which his friends vainly sought to cure by the charm of mole's blood (the blood of a live mole being allowed to drip on his head), they actually sent a messenger nearly a hundred miles to procure a bit of the skull of a suicide.

This treasure was scraped to dust and mixed with a cup of water, which the boy, ignorant of its contents, was make to drink! (An equally odd cure for consumption was, not long ago, fully believed in in the adjoining county of Sutherland, where the patient was made to drink warm blood drawn from his own arm. An instance of this was related to Sir James Simpson by one of the parties concerned. Dr. Mitchell has seen several epileptic idiots who had been subjected to the same treatment.)

Equally precious to the leech of the last century were the ashes of a burned witch collected from her funeral-pyre. Such were deemed a certain cure for gout or for fever, and eagerly were they gathered up and treasured.

Whatever may have been the special merit thus attaching to criminals (and we know that a strand from the rope with which a man had been hanged was long accounted an amulet against many ills), it is satisfactory to know that saints have had their share in this dubious honor. There is one sect of our fellow-Christians in Syria, namely, the Nestorians, who, while they eschew all veneration for relics, yet believe the remains of saints and martyrs to be endowed with such supernatural virtues, that at their wedding-feasts the dust of some reputed saint is invariably mixed with the wine in the marriage-cup—a custom which would seem to require numerous additions to their saintly calendar. Doubtless, however, the holy dust multiplies, that the supply may be equal to the demand.

But to return to this remarkable phase of cannibalism in Europe, we find that, just as the Chinese doctor sets most store by the animals imported from foreign lands, so did our ancestors chiefly prize a preparation of long-deceased Egyptians. Among the standard medicines quoted in the medical books of Nuremberg of two hundred years ago are "portions of the embalmed bodies of man's flesh, brought from the neighborhood of Memphis, where there are many bodies that have been buried for more than a thousand years, called *mumia*, which have been embalmed with costly salves and balsams, and smell strongly of myrrh, aloes, and other fragrant things." The writer further tells how, "when the sailors do reach the place where the mumia are, they fetch them out secretly by night, then carry them to the ship and conceal them, that they may not be seized, because certainly the Egyptians would not suffer their removal." Nevertheless, the sailors had no great liking for their cargo, believing it to be connected with unholy magic, and that ships having mummies on board would assuredly meet with terrible storms, and very likely be compelled to throw them as an offering to the angry waves.

These medicinal mummies were also imported from Teneriffe, where in olden days the natives used to embalm their dead, sew them in buckskin shrouds, and hide them in caves, whence they were stolen by traders. "White mummies" were also obtained from the coast of

Africa, where bodies of drowned mariners were sometimes washed ashore, and became dried up and shriveled as they lay unburied on the burning sands. These became so light as scarcely to weigh thirty pounds. They were, however, not considered so desirable as the genuine article from Alexandria, and were, moreover, more expensive.

The learned doctors of France, Germany, and Italy all made great use of this eccentric drug, and in the seventeenth century grievous complaints arose of its adulteration. Monsieur Pomet, chief apothecary to the French king, records that the king's physician went to Alexandria to judge for himself on this matter, and, having made friends with a Jewish dealer in mummies, was admitted to his storehouse, where he saw piles of bodies. He asked what kind of bodies were used, and how they were prepared. The Jew informed him that "he took such bodies as he could get, whether they died of some disease or of some contagion; he embalmed them with the sweepings of various old drugs, myrrh, aloes, pitch, and gums, wound them about with a cere-cloth, and then dried them in an oven, after which he sent them to Europe, and marveled to see the Christians were lovers of such filthiness."

But even this revelation did not suffice to put mummy-physic out of fashion, and we know that Francis I, of France, always carried with him a well-filled medicine-chest, of which this was the principal ingredient.

Old Sir Thomas Browne, after enumerating the various diseases for which divers great doctors recommend mummy as an infallible remedy, protests against such unworthy use of the ancient heroes, and declares that to serve up Chamnes and Amosis in electuaries and pills, or that Cheops and Psammetichus should be weighed out as drugs, is dismal vampirism, more horrible than the feasts of the ghouls.

The apothecaries of England were often well content to make use of a cheap substitute which answered quite as well, namely, the bones of ancient Britons. Dr. Toope, of Oxford, writing in 1685, tells how at the circles on Hakpen Hill, in Wiltshire, he had discovered a rare lot of human bones—skeletons, arranged in circles, with the feet toward the center. He says, "The bones were large and nearly rotten, but the teeth extream and wonderfully white." Undisturbed by any questions of reverence for these ancestors of his race, he adds "*I dug up many bushells, with which I made a noble medicine.*"

The mummy-trade was supported by various classes of the community, for artists declared that mummy-powder beaten up with oil, gave richer tones of brown than any other substance, and modern perfumers found means of preparing the perfumes and spices found inside the bodies, so as to make them exceedingly attractive to the ladies. Paper-manufacturers found that the wrappings of the mum-

mies could be converted into coarse paper for the use of grocers, and the cloth and rags were sometimes used as clothing—at least, so we are told by Abdallatif, a traveler of the twelfth century, who also records how one of his friends found in the tombs of Ghizeh a jar carefully sealed, which he opened, and found it to contain such excellent honey that he could not resist eating a good deal of it, and was only checked in his feast by drawing out a hair, whereupon he investigated further, and found the body of an ancient Egyptian baby in good condition, and adorned with jewels. He does not record how he enjoyed that meal in retrospect. Imagine dining off the honeyed essence of a baby-Pharaoh!

Is it not pitiful to think that all the skill so lavishly expended by the sages of ancient Egypt in rendering their bodies indestructible, should, after three thousand years, end in this? And, in truth, the mummies thus dealt with, had less reason to complain of their lot than the multitude which were broken up and sold at so much per ton to fertilize the fields of a far-distant and insignificant islet peopled by barbarians!

A very interesting point of similarity between the little shop of the old Japanese apothecary, and those of early English druggists, is suggested by the extensive use of calcined animal matter, recommended in the prescriptions which were most highly valued in England before the Norman Conquest, and which are recorded in elaborate Saxon manuscripts, carefully preserved in our national archives. These "leechdoms" are written in ancient black-letter characters, and are curiously illustrated with pictures of the herbs and animals which are recommended for medicinal use.

Our Saxon ancestors appear to have devoted considerable attention to the subject of their hair. Though ignorant of macassar-oil, they discovered that dead bees burned to ashes, and seethed in oil with leaves of willow, would stop hair from falling off; but should the hair be too thick, then must a swallow be burned to ashes under a tile, and the ashes be sprinkled on the head. But in order altogether to prevent the growth of hair, emmets' eggs rubbed on the place are found an effectual depilatory; "never will any hair come there."

Excellent also as a cure for deafness is the juice of emmet's eggs crushed, or else the gall of a goat, or, in extreme cases, boar's gall, bull's gall, and buck's gall, mixed in equal parts with honey, and dripped into the ear, sometimes with the addition of very nasty ingredients. But if earwigs had entered in, then the sufferer is bidden to "take the mickle great windlestraw, with two edges, which waxeth in highways, chew it into the ear; he, the earwig, will soon be off."

Even this poor insect was turned to account. One prescription desires that "the bowels of an earwig be pounded with the smede of wheaten meal and the netherward part (i. e., root) of marche, and mingled with honey."

For a hard tumor or swelling, goat's flesh burned to ashes and smudged on with water is found to be efficacious, as are also shavings off the horn of a hart to disperse ill-humors and gatherings. Wood-ashes seethed in resin, or goat's horn burned and mingled with water, or its dung dried and grated and mingled with lard, were all good remedies for swellings.

For erysipelas, the prescriptions are numerous. A plaster of earth-worms, or of bullock's dung, still warm is recommended; but, better still, "For that ilk, take a swallow's nest, break it away altogether, and burn it, with its dung and all; rub it to dust, mingle with vine-gar, and smear therewith." For pain of jowl, burn a swallow to dust, and mingle him with field-bee's honey. Give the man that to eat frequently.

To the value of every portion of a fox not even the fairy-lore of Japan can bear higher testimony. The man who has disease of the joints is advised to take a living fox and seethe him till the bones alone be left, and then bathe repeatedly in this foxy essence. And every year he shall prepare himself this support, and let him add oil thereto, when he seetheth him. Wonderfully it healeth!

For sore of ears and dimness of eyes, a fox's gall mingled with oil or with honey is recommended, and "the fat of the fox's loin melted and dropped in the ear also bringeth health. For oppressive, hard-drawn breathing, a fox's lung sodden and put into sweetened wine and administered, wonderfully healeth." A salve of fox's grease min-gled with tar would heal all manner of sores, while his liver worked cures quite as notable as those recorded in Japan. Shoes lined with vixen-hide were recommended to those who suffered from foot-addle —i. e., gout.

Next in value to the fox ranks the hare, whose brain drunk in wine "wonderfully amendeth" an indolent tendency to oversleep. Its lung, bound on the sore, healeth both eyes and feet. The hare's gall, mingled with honey, brighteneth the eyes. The lung and liver, mingled with myrrh and boiled in vinegar, cures giddiness. The sin-ews swallowed raw are an antidote against bite of spiders; and the rennet administered in wine against that of serpents. The heart min-gled with dust of frankincense heals various forms of disease, while baldness is averted by smearing the head with oil in which have been seethed portions of this poor little animal. "Then the hair holdeth on, and the salve compels that it shall grow."

If the gums of a child be frequently rubbed with a hare's brain sodden, then shall its teeth wax without sore. The milk of a she-wolf was held equally efficacious, but more difficult to obtain!

Next in order of merit comes the he-goat, whose liver pounded with vinegar is found valuable as a styptic, as is also his blood dried and reduced to dust; goat's gall is a cosmetic which will remove all unsightly spots and specks from off the face; mingled with apple-

juice it heals diseases of the ear, or, with oil, is a remedy for tooth-ache. If a child be epileptic, "draw the brain of a mountain-goat through a golden-ring; give it to the child to swallow before it tastes milk; it will be healed." "To get sleep, a goat's horn laid under the head turneth waking into sleep." A goat's horn, roasted and pounded with acid, reduces the inflammation of erysipelas. Goat's grease and blood mingled with barley-meal forms a soothing poultice, while pills of goat's grease and a draught of its blood are recommended for dropsy.

Many and indescribably disgusting are the other remedies derived from the goat. A Brahman, reverentially swallowing a little of each product of the sacred cow, would shrink with loathing from the leechdoms of the early English, so important a place do they assign to preparations of the excrement of divers animals, but chiefly of bulls, of swine, of dogs, and of goats. These, and many other foul ingredients are compounded in every conceivable manner, and prescribed not merely for medicinal baths and plasters for external use, but as most unsavory physic for the inner man.

A less nasty remedy was bull's marrow, administered in wine to check spasms, while its gall was prescribed for divers diseases; moreover, it was well known that snakes would flee from any place where a bull's horn, burned to ashes, had been sprinkled.

The brain, lung, and liver of the boar are largely prescribed, while for nausea "boar's suet boiled down, and with boar's foam added thereto, is so sure a remedy that the patient will wonder, and will ween that it be some other leechdom that he drank." A pleasant cure for sleeplessness is to lay a wolf's head under the pillow; while wolf's flesh, well seasoned, counteracts devil sickness and an ill-sight. A draught of wolf's milk, mingled with wine and honey, was a potent remedy for women in dire suffering; while an ointment made from the right eye of a wolf was the best prescription that the Saxon oculist could command. The head-bone or skull of a wolf, when burned thoroughly and finely pounded, would heal racking pain in the joints, and the ashes of a swine's jaw are to be laid on the bite of a mad dog.

Truly valuable was lion's suet, of which it is stated "it relieveth every sore." Elephant bone or ivory, pounded with honey, is an infallible cosmetic, removing all blemishes from the face. "For the kingly disease, jaundice, the head of a mad dog, pounded and mingled for a drink with wine, healeth. For cancer, the head of a mad dog, burned to ashes and spread on the sore, healeth the cancer-wounds; while, for laceration by a mad dog, a hound's head burned to ashes, and thereon applied, casteth out all the venom and the foulness, and healeth the maddening bites." "For pain of teeth, burn to ashes the tusks of a hound; sprinkle the dust in wine, and let the man drink. The teeth shall be whole."

Another effectual remedy, for cancer, is to burn a fresh hound's head to ashes and apply to the wound. Failing relief, human excrement, dried and reduced to dust, may be tried. "If, with this, thou art not able to cure him, thou mayest never do it by any means!"

An excellent remedy for imperfect sight was an ointment of honey mixed with the fatty parts of all manner of river-fishes. Another, equally efficacious, was a compound of dumbledore's honey with the ashes of burned periwinkle. It was, however, requisite that certain mystic words should be uttered while gathering the periwinkle, a wort which had special power to counteract demoniacal possession and devil-sicknesses. The ashes of the elder-tree were applied in cases of palsy, for which a plaster of earth-worms, well pounded, is also accounted excellent.

We may well believe that, for convenience' sake, many of these calcined plants and animals were prepared at leisure and stored, ready for use in cases of emergency. Consequently, though we can hardly flatter ourselves that our ancestors were as exquisite in their neatness as the Japanese, doubtless this little druggist's shop in Osaka gives us a very fair notion of the surroundings of a learned Saxon leech, in whose repositories were earthenware jars of every size, containing the ashes of goat's flesh, of dead bees, of wolf's skull or swine's jaw, of divers shell-fish, of worts and rinds without number—nay, even of human skulls and bones. On the walls hung bunches of dried herbs and remains of birds and lizards, rats, moles, and such small deer, together with skins of serpents, portions of mummies, horns of stags, rhinoceros, narwhal, elephants' tusks, and many other items of the strange materia medica of our own ancestors.

The foregoing "leechdoms" are fair samples of the voluminous pharmacopœia of Britain in the tenth century. But to us, who pride ourselves on the medical skill of the present day, it is truly marvelous to find that *the early part of the eighteenth century should show so little, if any, advance on the ignorance which prevailed at the date of the Norman Conquest.* Here is a rare old volume which was printed in the Cowgate of Edinburgh in 1712. It is "A Collection of useful Remedies for most Distempers. . . . Collected by John Moncrief, the laird of Tippermalluch, a person of extraordinary skill and knowledge in the art of physick, and who performed many stupendous cures by these simple remedies."

His volume contains innumerable directions for the preparation of divers herbs, and also a multitude of prescriptions of animal substances so inexpressibly loathsome as to make it a matter of marvel how any one could be found either to prepare them, or to submit to their application. Salts of ammonia in the crudest form were a favorite remedy for external or internal use.

By far the least objectionable compounds were those prepared from carbonized animals in the Japanese or early Saxon manner. Thus

"for a dangerous squinance or quinsy" Tippermalluch bids his disciples—

Take old Swallows, and burn them in a pot, take the powder thereof and mix it with Honey and anoint the Throat therewith. A plaister of a Swallow's Nest dissolves humours of the Gorge and Chouks. Ashes of worms applyed with honey draws out little broken bones.

For falling of the hair. Make a Lee of the Ashes of Cow's Dung, wherewith wash the Head. The burnt Ashes of little Froggs applyed cures the falling of the hair, called Alopecia. The burnt Ashes of Goats Dung mixt with Oyl, anointed, multiplys the Hair. The Ashes of a Goat's Hoof mixed with Pitch healeth the Alopecia. The Ashes of Bees mixt with Oyl, or the ashes of Southernwood mixt with old Oyl, causeth hair to grow. A Lee of the Ashes of Ivie-tree-Bark causeth hair grow yellow. The Blood of a shell Crab anointed, breeds much hair. But the Blood of a Bat, or a little Frog, the powder of a Swan's Bones, or the Milk of a Bitch hinders the growing of the hair. The bark of the Sallow Tree dissolved in Oyl maketh the hair black. The decoction of the flowers of broom dye it yellow. To make Curl'd hair. Ashphodele roots rubbed on the head, the same being first raz'd (i. e., shaven).

For the cure of the disease called Lethargie burn the whole skin of a Hare, with the ears and nails, and give the patient the powder thereof warm. The smoak of Kid's leather burnt, holden to the Nose, awakens them powerfully. Ashes of Hartshorn burnt, mixt with the Oyl of Roses and anointed on the forehead and temples, causeth a pleasant sleep.

For Cancer, the Ashes of a Dog's head, or burnt human dung.

The Ancle-bones of a Swine or the hoofs of a Cow, burnt and drunk, cures the Colick. Hare's blood fryed, taken, Rosted Hare's flesh eaten, the Ashes of a Hare, burnt whole, Ashes of burnt willow, or Ashes of the bark of the Elm-tree cureth burning or scalding. Powder of the burnt hairs of a hare cures St. Anthonies Fire, i. e., Erysipelas.

Here are valuable styptics to stanch bleeding of the Nose. Make a powder of the blood of the Patient after it is burnt, and blow it up in the Nose. It powerfully stays the bleeding. Snails with the shells bruised, put in. Juice of Swine's dung, put in. Hold before your eyes the herb sheepherd's scrip, or Vervain, or Knot-grass. *These herbs have that propertie, by looking on them, to stanch blood.*

Ashes of a Frog well burnt in a Pot, gleweth Veins and Arteries and cures Burning. Ashes of Hen's feathers burnt, or ashes of Nettles snuffed up. The blood of a Partridge, of an Ozell, of a Dove, applyed, stayeth the flowing of the blood most healthfully. The blood of a Cow put in the wound.

Cause the patient to ly on his back all naked, and drop on his Face Water and Vinegar. This is a most sure Cure. Steep a Hare's hair in Water and Vinegar, put it in the Nose and it will produce a marvellous effect.

Or take a Toad, dry it very well before the Sun, put it in a Linnen cloath and hang it with a string about the party that bleedeth. Let it touch the breast of the Left side near the Heart. Spiders pulverised and snuffed stops blood.

I think the Japanese gentleman who was so much annoyed at my having obtained a glimpse of "the foolishness" of old Japanese medicine, might have wondered a good deal had he got hold of some English prescriptions of the last century!

From an almost endless catalogue of healing-spells which are *to*

this day practiced by the peasantry of various districts in England and Scotland, I will quote a few which are considered certain remedies. The Northumbrian cure for warts is to take a large black snail, rub the wart well with it, and then impale the poor snail on a thorn-hedge. As the poor creature wastes away, the warts will surely disappear.

In the west of England eel's blood serves the same purpose. For goître or wen a far more horrible charm must be tried. The hand of a dead child must be rubbed nine times across the lump, or, still better, the hand of a suicide. It is not many years since a poor woman living in the neighborhood of Hartlepool, acting on the advice of a "wise woman," went alone by night to an out-house where lay the corpse of a suicide awaiting the coroner's inquest. She lay all night with the hand of the corpse resting on her wen; but the mental shock of that night of horror was such that she shortly afterward died.

In the neighborhood of Stamfordham, in Northumberland, whooping-cough is cured by putting the head of a live trout into the mouth of the patient, and letting the trout breathe into the child's mouth. Or else a hairy caterpillar is put in a small bag and tied round the neck of the child, whose cough ceases as the insect dies.

A peculiar class of remedy is that of making offerings of hair as a cure for whooping-cough. In Sunderland, the crown of the head is shaved, and the hair hung upon a bush or tree, in full faith that, as the birds carry away the hair, so will the cough vanish. In Lincolnshire, a girl suffering from ague, cuts a lock of her hair, and binds it round an aspen-tree, praying it to shake in her stead. In Ross-shire, where living cocks are still occasionally buried as a sacrificial remedy for epilepsy, some of the hair of the patient is generally added to the offering. And at least one holy well in Ireland (that of Tubber Quan, near Carrick-on-Suir) requires an offering of hair from all Christian pilgrims who come here on the last three Sundays in June to worship St. Quan; part of the ceremonial required is that they should go thrice round a neighboring tree on their bare knees, and then each must cut off a lock of his hair, and tie it to a branch as a charm against headache. The tree, thus fringed with human hair of all colors, some newly cut, some sun-bleached, is a curious sight, and an object of deep veneration.

Travelers who remember the tufts of hair which figure so largely among the votive offerings in Japanese temples, may trace some feeling in common between the kindred superstitions of these Eastern and Western isles.

Hideous is the remedy for toothache practiced at Tavistock in Devonshire, where a tooth must be bitten from a skull in the churchyard, and kept always in the pocket.

Spiders are largely concerned in the cure of ague. In Ireland the sufferer is advised to swallow a living spider. In Somerset and

neighboring counties, he is to shut a large black spider in a box and leave it to perish ; while in Flanders he is to imprison one in an empty walnut-shell, and wear it round his neck. Even in sturdy New England a lingering faith in the superstitions of the old mother-country leads to the manufacture of pills of spider's web as a cure for ague, and Longfellow tells of a popular cure for fever "by wearing a spider hung round one's neck in a nutshell." This was the approved remedy of our British ancestors for fever and ague ; and I am told that in Sussex the prescription of a live spider rolled up in butter is still considered good in cases of obstinate jaundice.

Many and horrible are the remedies for erysipelas. Thus, at Loch Carron, in Ross-shire, we knew of a case in which the patient was instructed to cut off one half of the ear of a cat, and let the blood drip on the inflamed surface.

It appears that the old superstition may even survive in such an atmosphere of strong common sense as that of Pennsylvania, where so recently as the year 1867, a case was reported in which a woman was found to have administered three drops of a black cat's blood to a child as a remedy for croup. Her neighbors objected to her pharmacy, and proved their superior wisdom by publicly accusing her of witchcraft.

In Cornwall the shedding of blood is not required. The treatment prescribed for the removal of "whelks" or small pimples from the eyelids of children is simply to pass the tail of a black cat nine times over the part affected.

Of the burial of a living cock on behalf of an epileptic patient, we have had many instances in the north of Scotland in the present century, but this savors rather of devil-propitiation and sacrifice than of medicine-lore.

In Devonshire the approved treatment for scrofula at the present day is to dry the hind-leg of a toad and wear it round the neck in a silken bag, or else they cut off that part of the living reptile which answers to the part affected by scrofula, and, having wrapped the fragment in parchment, tie it round the neck of the sufferer. In cases of rheumatism, a "wise man" of Devonshire will burn a toad to ashes, and tie the dust in a bit of silk to be worn round the throat.

So recently as 1822, one of these quacks traveled through England "in his own gig." Each patient who consulted him was required to bring him a fee of seven shillings and a live toad. He pocketed the shillings and cut the hind-legs off the luckless toads, placing them in small bags, which he solemnly hung round the neck of the sufferer, who was required to wear this unfragrant appendage till the leg was quite decayed !

For the same malady the same remedy was in the last century recommended by a beggar-wife to a girl at Gaddesden who had been a sufferer from her infancy. It is stated that the cure was effected, and

that the girl never suffered afterward. But it is worthy of note that the beggar-wife explained that the efficacy of the charm lay in the death of the poor mutilated toad, which, deprived of its legs, would pine and die, but as it slowly wasted so would the distemper pass away. Here, then, as in the offering of the live cock, was involved the principle of sacrifice—a life for a life.

Another girl in the same village was partly cured of the "evil" in her eyes by applying a sun-dried toad to the back of her neck, whereby blisters were raised. Poor toads are still made to do service in divers manners in Cornwall and Northampton for the cure of nose-bleeding and quinsy; while "toad-powder," or even a live toad or spider shut up in a box, is still, in some places, accounted as useful a charm against contagion as it was in the days of Sir Kenelm Digby. The medicine known to our ancestors as *Pulvis Æthiopicus* (a valuable remedy both for external and internal use in the treatment of small-pox and dropsy) was neither more nor less than powdered toad.

Frogs are well-nigh as valuable as toads to the sick poor, who are rarely lacking in the primary necessity of faith in the means adopted. Thus, frog's spawn, placed in a stone jar and buried for three months till it turns to water, has been found wonderfully efficacious in Donegal, when well rubbed into a rheumatic limb. How much of the credit was due to the rubbing is not recorded. In Aberdeenshire a cure recommended for sore eyes is to lick the eyes of a live frog. The man who has thus been healed has henceforth the power of curing all sore eyes by merely licking them! In like manner it is said in Ireland that the tongue which has licked a lizard all over will be for ever endued with a marvelous power of healing whatever sore or pain it touches.

Another Irish remedy is to apply the tongue of a fox to draw a troublesome thorn from the foot; the tooth of a living fox to be worn as an amulet is also deemed valuable as a cure for an inflamed leg. The primary difficulty is to catch the fox and extract his tooth!

With respect to deep-seated thorns, the application of a cast-off snake-skin is efficacious, not to attract the thorn toward itself, but to expel it from the opposite side of the hand or foot. But, once we touch on the virtues of the mystic snake, we find its reputation just as great in Britain's medicine folk-lore as in Japan, where the great snake-skins held so conspicuous a place in the druggist's shop, or in China, where the skin of a white-spotted snake is valued as the most efficacious remedy for palsy, leprosy, and rheumatism.

Strange to say, in the old Gaelic legends, there is a certain white snake who receives unbounded reverence as the king of snakes, and another legend tells of a nest containing six brown adders and *one pure white one*, which latter, if it can be caught and boiled, confers

wondrous medical skill on the lucky man who tastes of the serpent-broth.*

In some of the Hebridean Isles, notably that of Lewis, the greatest faith prevails in the efficacy of so-called "serpent-stones," which are simply perforated, water-worn stones. Some have had two plain circles cut upon them. These are dipped in water, which is then given to cattle as a cure for swelling or for snake-bite. Should such a charmed stone be unattainable (and their number is exceedingly limited), *the head of an adder may be tied to a string and dipped in the water, with equally good result.*

The oft-quoted remedy, "A hair of the dog that bit you," appears in many forms. In Devonshire, any person bitten by a viper is advised at once to kill the creature and rub the wound with its fat. I am told that this practice has survived in some of the Northern States of America, where the flesh of a rattlesnake is accounted the best cure for its own bite.

In Black's very interesting volume on "Folk-Medicine," he mentions that the belief in the power of snake-skin as a cure for rheumatism still exists among the sturdy New-Englanders, some of whom are not above the weakness of wearing a snake-skin round the neck, or keeping a pet snake as a charm. The use by American Indians of rattlesnake-oil for the same malady seems not devoid of reason; but the New England faith in snake-skin is probably a direct heritage from Britain, where Mr. Black tells of an old man who used to sit on the steps of King's College Chapel, at Cambridge, and earn his living by exhibiting the common English snake, and selling the sloughs of snakes, to be bound round the forehead and temples of persons suffering from headache.

In Durham, an eel's skin worn as a garter round the naked leg is considered a preventive of cramp, while in Northumberland it is esteemed the best bandage for a sprained limb.

So, too, in Sussex, the approved cure for a swollen neck is to draw a snake nine times across the throat of the sufferer, after which operation the snake is killed, and its skin sewed in a piece of silk and worn round the patient's neck. Sometimes the snake is put in a bottle, which is tightly corked and buried in the ground, and it is expected that, as the victim decays, the swelling will subside.

The quaint little drug-store at Osaka has led me into a long talk; but the subject is a large one, and the chief difficulty lies in selecting a few examples from the mass of material before me. I am sure that should these pages ever meet the eye of my Japanese friend, he will acknowledge that my interest in the medicine-lore of his ancestors was certainly justifiable.—*Nineteenth Century.*

* See "In the Hebrides," by C. F. Gordon Cumming, London, Chatto & Windus.

THE ECONOMIC DISTURBANCES SINCE 1873.

By Hon. DAVID A. WELLS, LL. D., D. C. L.

IV.

DEPRESSION of prices has, to a large extent, been accepted as a prime cause of the "economic disturbance" which has prevailed since 1873. Indeed, Mr. Robert Giffen, the well-known English economist and officer of the British Board of Trade, in an article contributed to the "Contemporary Review," June, 1885, does not hesitate to express the opinion that "it is clearly unnecessary to assign any other cause for the gloom of the last year or two;" and continuing, he further says:

"The point to which I would draw special attention is, that . . . the most disastrous characteristic of the recent fall of prices has been the descent all round to a lower range than that of which there had been any previous experience. It is this peculiarity which—more than anything else—has aggravated the gloom of merchants and capitalists during the last few years. Fluctuations of prices they are used to. Merchants know that there is one range of prices in a time of buoyancy and inflation, and quite another range of prices in times of discredit. By the customary oscillations, the shrewder business people are enabled to make large profits, but during the last few years the shrewder, as well as the less shrewd, have been tried. Operations they ventured on when prices were falling to the customary low level have failed disastrously, because of a further fall which is altogether without precedent. The change is more like a revolution in prices than anything which usually happens in an ordinary cycle of prosperity and depression in trade."

Here, then, is a description of the extent of the recent fall in prices, and its influence in producing and aggravating the gloom of merchants and capitalists, by one well competent to appreciate and describe what has happened. The point of novelty and greatest significance, however, in Mr. Giffen's statement is, not that a depression of prices has been productive of gloom and a depression of business—for no fact is better recognized by all economists and business men than that on a falling market trade is always stagnant, and that nothing is more productive of gloom to the industrial and mercantile community owning or carrying stocks of merchandise than losses experienced or anticipated through a fall in prices; but that the recent fall in the prices of the great staple commodities of the world has been in extent and character without precedent in the world's history.*

A further fact of the highest importance, and one that is not dis-

* "Many who discuss this question, and whose opinions generally command deference, appear scarcely to realize the enormous extent of the fall, and it is only by means of very extensive statistics and of a comparison of various periods that a clear insight into the details and a broad view of the whole can be gained."—Augustus Sauerbeck *Journal of the Statistical Society of London, September, 1886.*

puted, is, that no peculiarity of currency, banking, or standard of value, or form of government, or incidence and degree of taxation, or military system, or condition of land tenure, or legislation respecting trade, tariffs and bounties, or differences in the relations between capital and labor in different countries, has been sufficient to guard and save any nation from the economic disturbances or trade depression which has been incident to such changes in prices.

An analysis of British exports and imports for 1886, with comparisons of similar data for the previous year, 1885 (presented by the "London Economist" in its issues for January 22 and 29, 1887), furnishes, moreover, some information, almost, if not fully, in the nature of a demonstration of the continued tendency of prices to decline during the latest period for which accurate data are (at present) accessible, and also of the continued universality of such tendency. Thus, looking first at exports, it appears that there was an increase during the year 1886 in the quantities of British and colonial commodities exported of 6·02 per cent, as compared with similar aggregates for 1885; or Great Britain sent out 106,020 pounds, tons, or other quantities in 1886, in place of 100,000 in 1885. Comparing, however, the sum which the quantities actually exported in 1886 would have cost at the prices of 1885, a decline in price is indicated of 6·34 per cent; or while sending away 106,020 pounds, tons, or other quantities in 1886, as compared with 100,000 in 1885, Great Britain received back in money value only $93,660 for the same quantities which in the previous year brought $100,000.

"A similar examination of British imports for 1886 also brings out the further interesting fact that the average decline in the prices of the goods imported was almost precisely the same as in prices of goods exported. The increase in quantities of imports was less than one per cent; or the country brought in 100,796 pounds, tons, or other quantities, in place of 100,000 in 1885. But the decline in prices was 6·373 per cent; so that the country paid only $93,627 for the same quantities for which it paid $100,000 in the previous year. The decline in the general range of prices for the year 1886, as measured by the actual exports and imports of the greatest exporting and importing nation of the world, would therefore appear to have been in excess of six per cent; and this decline would seem to have occurred during the same period in all those countries in which Great Britain deals as a seller equally with those in which she deals as a buyer; or, in other words, this decline was practically universal." *

The question which here naturally suggests itself, as to what in general has been the extent of the recent fall in prices, is perhaps best answered from the basis of English figures, by Mr. Augustus Sauerbeck, who, as the result of an exhaustive inquiry into the price movements of thirty-eight leading articles of raw produce since 1818–'27

* New York Commercial Bulletin.

(communicated to the Statistical Society of London and published in the journal of their "Proceedings" for September, 1886, and March, 1887), has arrived at the following conclusions: There was a persistent decline in the average prices of general commodities in England from the beginning to the middle of the present century; or, more exactly, to 1849. From thence there was an advance, which culminated in 1873. But leaving out of consideration a remarkable speculative period from 1870 to 1874, coincident with the Franco-German War and the payment of the war indemnity by France, during which period prices rose with great rapidity from 1870 to 1873, and fell in the succeeding year (1874) below their average starting-point in 1870, the decline of prices may be regarded as having been continuous from 1864 to 1886. Compared with the average prices of general commodities from 1867–'77, the period from 1878–'85 shows a depreciation of 18 per cent. But if the average prices of 1885 alone be taken, the decline from the average for 1867–'77 is 28 per cent; or continuing the comparison through 1886 and embracing a somewhat larger number of articles, the average depreciation, in the opinion of Mr. Sauerbeck, has amounted to 31 per cent. Furthermore, the average level of prices for 1886, according to the tables of Mr. Sauerbeck, was considerably below the average for the year 1848, which in turn appears to have been the lowest previous point for the century subsequent to 1820.

Many similar inquiries, embracing in some instances a much larger number of articles than were selected by Mr. Sauerbeck, have been instituted in recent years by other investigators in England, France, Germany, and the United States; but the conclusions arrived at are respectively so divergent that no figure representing the average decline during the period under investigation would probably be universally accepted as in every way satisfactory and conclusive.*

The usual method employed by European economists in order to form a correct idea of the changes of prices in one period as compared with another, is to take the prices of certain selected commodities in a given year, or the average prices of a series of years, as the standard; represent this by the figure 100 or 1,000, and then note the increase or decrease in price in the case of each article in each subsequent year in proportion to this standard. Combining the percentage of price alterations among all the articles, a total of the variations experienced becomes known, and the number thus obtained is termed an *index number* for the year, or other period under consideration; or a number expressive of the ratio of price at a given date to the average of some former period. Thus, for example, if the average prices of forty articles in the year 1880 were to be taken at

* The so-called "Hamburg" tables published by the well-known German statistician, Dr. Soetbeer, in 1886, make the average of prices in 1885 10 per cent higher than they were in 1847–'50.

100, and the average decline in the prices of these same articles for the year 1810 was found to be 20 per cent, the index number for the year 1800 would be 100, and for the year 1810, 80.*

The difficulties in the way of obtaining satisfactory averages from comparisons of prices at different periods by the above or any other methods are, however, almost insuperable; so that it may well be doubted whether the determination of an average of general prices is ever within the bounds of possibility. Quotations for a given day, or month, do not necessarily show the average for the year; and, in like manner, the selection of a limited number of articles for comparison can not insure correct conclusions respecting the movement of prices in general. All methods of comparing price variations which content themselves with mere average quotations of different articles, and which do not pay due regard to the relative importance of each article in the domestic and foreign commerce of a country; which, for example, allow a change of 80 per cent in the price of an article like cochineal, of which the value sold in any one year is small, to balance a change of 2 per cent in an article, like sugar, the value of which annually sold is enormous, are also in a great degree deceptive and worthless;† and even when in the comparison of prices, the importance of considering relative quantities is fully recognized, the data for ascertaining these relations are extremely uncertain and questionable. The utmost of service that all such tabular comparisons of prices, even when prepared with all desirable qualifications, are capable of rendering, would, therefore, seem to be limited to the affording of important inferences respecting variations of prices, or to the showing

* For a full exhibit and discussion of these tables, reference is made to a paper prepared and laid before the British Royal Commission (third report, Appendix B, pp. 312–390, 1886), by R. H. Inglis Palgrave, F. R. S.; and also to an article in the (Harvard) "Quarterly Journal of Economics" (vol. i, No. 3, Boston, 1887), by Professor J. Laurence Laughlin, Professor of Political Economy, Harvard University.

† One of the best-known tables of this character, embracing twenty-two different articles, has been kept by the London "Economist" for many years as a constituent element of current British commercial history; and the objections inherent in the system adopted are forcibly illustrated by the following recent occurrence, to which attention has been called by the "New York Commercial Bulletin": Thus, a comparison of index numbers for January and July, 1886, and for January, 1887, as deduced from the "Economist's" tables of prices, indicated a small advance for the latter month in the general level of British prices. But the first article on the "Economist's" list of prices is coffee, which advanced from July 1, 1886, to January, 1887, to a degree sufficient to alone add 50 to the index number of January; while the entire increase for the whole twenty-two articles was only 36; or, in other words, if coffee alone were omitted from the list of articles compared, the net result would show an apparent decline instead of any advance in the general level of prices. "Certainly," as the "Commercial Bulletin" remarks, "it is difficult to attach much importance to results having no better basis than this. For coffee is by no means one of the most important articles compared; it is greatly exceeded in importance by at least twelve of them. But the change in that one article happens to have been surprisingly great, and it thus outweighs far more important changes in other articles, such as iron or meats."

whether a pound sterling or a dollar would have bought more or less of a given number of bushels, yards, or pounds at one time than another. In all other respects they are little other than curiosities; inasmuch as if some articles in a given period have risen and others have fallen in price, and if the fall of some and the rise of others can be undoubtedly traced to the action of entirely different causes, the grouping of these facts into the form of tables, and the endeavor to reduce the sum of the respective changes to a common average, can prove nothing whatever as to the cause or causes which have been operative in producing the changes. And between such discordant results effected by entirely diverse influences, there would, furthermore, seem to be no possibility of establishing an average; for the price of some articles, whose use has been superseded or impaired by change of fashion or new inventions, may fall nearly or quite to zero, while the price of others, by reason of increased demand or interrupted supply, may rise almost to infinity by comparison; and between such extremes there may be any number of gradations.

All, therefore, that can be confidently affirmed in respect to the extent of the recent depression of prices is, that comparing the data for 1885–'86 with those of 1866–'76, the decline has been extraordinary and has affected most articles and most countries; and that the estimate of Mr. Sauerbeck (before referred to), of 30 per cent as the average measure or extent of the decline, is not excessive.

It seems almost unnecessary to remark, that a fall of prices, although commonly so considered, can not, in any comprehensive discussion, be regarded as in any sense a primary cause of economic disturbances; but that here again something antecedent in the nature of a cause or causes, more or less general, must be sought for in explanation. And of such causes, two only that are worthy of attention have been suggested: *First*, a great multiplication and cheapening of commodities through new conditions of production and distribution, which in turn have been mainly due to the progress of invention and discovery; and, *second*, that the precious metal used for standard money, viz., gold, has, through relative scarcity, owing to diminished production and increased demand, greatly appreciated in value; in consequence of which a given amount of gold buys more than formerly; or, what is the same thing, the price or purchasing power of commodities, in comparison with gold, has fallen.

As to which of these two causes has been most influential in occasioning the recent great decline in prices, the best authorities who have investigated the subject, as is well known, widely differ. It is also well recognized that the determination of this question is almost fundamental in the so-called bimetallic controversy; the plea for an increased use of silver as money being wholly predicated on an alleged insufficiency in the supply of gold for effecting the world's exchanges, while ample evidence of the scarcity of gold is claimed to be found in

the remarkable fall of prices which has been recently experienced. It is, however, a universally accepted canon, alike in logic and common sense, that extraordinary and complex agencies should never be invoked for the explanation of phenomena, so long as ordinary and simple ones are equally available and satisfactory for the same purpose. And with this premise, it is a matter of the highest interest and importance to observe how, with very few exceptions, the phenomenal decline in recent years of the prices of the world's great staple commodities admits not only of a ready and complete explanation in accordance with the first cause, but is, in fact, in the nature of an inevitable sequence from it; and, in support of this proposition, attention is asked to the nature of the agencies which have been so identical, absolute, and exclusive in determining the recent decline of prices in the case of such a number of what must be regarded as typically staple commodities, that their conjoined experiences would seem so fully to establish a rule, as almost to compel all antagonizing results, especially in the case of products of minor importance, to be regarded in the light of unimportant exceptions.

What these agencies have been, how they have acted, and what disturbing influences they have exerted on the world's prices, on the world's industries, commerce, and consumption, and on pre-existing relations of labor and capital, will, when fully told, constitute one of the most important and interesting chapters of political economy and commercial history. Such a complete statement it is not at present proposed to attempt; but the following exhibit of results, derived from a study of what may be termed the recent production and price experiences of a considerable number of important commodities, will, it is thought, better contribute to an understanding of the situation, and to a solution of the difficult economic problems involved in it, than any other method hitherto adopted.*

The commodity of prime importance in the commerce and consumption of the world, which appears to have experienced the greatest recent decline in price, is *sugar*, which has fallen to a lower rate than has ever been known in the history of modern commerce; the wholesale price of fair refining sugars having been more than 114 per cent higher in 1880 than in the first half of the year 1887.†

Now, while improved methods of manufacture and greater and

* "A general movement in prices is the resultant of a number of particular movements, and in these particular movements, again, we find the proximate causes of the distribution of the industrial forces of the world and of the wealth which these forces create."—PROFESSOR NICHOLSON, *University of Edinburgh, etc.*

† How continuous and regular has been the decline in the price of sugars in recent years is shown by the following table, which exhibits the average price of fair refining sugars in bond (or free of duty) in New York from 1880 to July, 1887, inclusive:

1880, 5·08 cents.	1885, 3·06 cents.
1882, 4·53 cents.	1886, 2·92 cents.
1884, 3·31 cents.	1887 (lowest to July), 2·37⅛.

cheaper facilities for transportation have undoubtedly contributed to such a result, it has been mainly due to an apparent desire, as M. Leroy-Beaulieu has expressed it, on the part of the Governments of France, Germany, Austria, Belgium, Holland, Italy, and Russia, "to make their national sugar industry the greatest in the world" by stimulating the domestic production of this commodity by the payment of extraordinary bounties on its exportation to other countries; or, in other words, by competing with one another in paying large sums for the purpose of speedily getting rid, at little or no profit, of one of the most valuable and highly-desired products of human industry.

On the other hand, in order to neutralize to some extent the exceptional advantages enjoyed through such an economic policy by the producers of beet-sugar in Europe, some of the cane-growing countries have felt obliged to encourage, by subsidies or tax-exemptions, their own sugar-production. In both Brazil and the Argentine Republic the manufacturers of cane-sugar have obtained a guarantee from the state of a five to six per cent return on their capital invested; while all the machinery needed in this industry may be imported free of duty. In the Spanish West Indies the home government has finally (1887) felt compelled to relinquish the export duties on sugars—the produce of Cuba and Porto Rico—which have long been regarded as almost indispensable on account of revenue necessities; while in South Africa and Australia the production of sugar has also been encouraged to such an extent that both of these countries will hereafter be undoubtedly included among the number of important sugar-exporting regions. In Central America, the British and Dutch West India Islands, Guiana, and India (which last produces more sugar than any other country) production has not as yet been artificially encouraged, and, with the exception of the levying of export taxes in certain localities, neither have any impediments been placed in the way of the natural growth of production. But at the same time it can not be doubted that the recent increased facilities for transportation and communication have, as before pointed out, been in the nature of a stimulus to the production of sugar, in common with all other commodities, and have opened up large and fertile sections of the earth, which a quarter of a century ago were practically inaccessible.

Under such conditions the increase in the production of sugar entering into the world's commerce, and available for general consumption, has been extraordinary. Mr. Sauerbeck estimates the increase from 1872–'73 to 1885–'86 to have been 68 per cent. Other authorities estimate the increase from 1853 to 1884, exclusive of the product of India and China, to have been at the rate of 30 per cent for each decade—or about 100 per cent compounded. In the Hawaiian Islands, where a remission of duties on sugars exported to the United States is equivalent to an export bounty of about 100 per cent, the domestic production of sugar has increased from about 12,000 tons in

1875 (the year before the duties were remitted) to 110,000 tons in 1886, an increase in eleven years of 750 per cent. The part that beet-root sugar has played in this increase is shown by the circumstance that while in 1860 the proportion of this variety to the whole sugar-product of the world (commercially reported) was less than 20 per cent, the product for 1886–'87 is estimated as in excess of 55 per cent; Germany alone having increased her product from about 200,000 tons in 1876 to 594,000 tons in 1880–'81, and to 1,155,000 tons in 1884–'85; while the increase of the beet-sugar product in the other bounty-paying states of Europe was not disproportionate.

Of this extraordinary increase of product, as large a proportion as foreign markets would take was, as a matter of course, exported in order to obtain the benefit of the government bounties on exports; the sugar-export of Germany alone increasing from about 500,000 cwt. in 1876 to over 6,000,000 cwt. in 1885, and, with every increase of exportation, the government disbursements on account of export bounties increased proportionally. The export bounty paid by Russia is estimated to have been as high at one time as $31.25 (£6 8s.) per ton; and that of France at between $35 and $40 (£7 and £8), entailing a present direct and indirect tax (French colonial sugars being admitted to the home market at reduced import rates), according to estimates recently presented by M. Dauphin, in the French Chamber of Deputies, of £3,280,000 ($16,400,000) per annum. In Germany the amount paid in the way of subsidies on sugar was estimated by Deputy Gehlert, in a speech in the German Reichstag in 1886, as having up to that time approximated $40,000,000; while for the year 1885, $10,000,000, it was claimed would be necessary, or an amount equal to the total wages paid to all workmen in all the German sugar-refineries. As might also have been expected, the profits of producers, and more especially of the sugar-refiners, working under the bounty (export) system, were at the same time enormously increased. In Germany the largest and best-managed beet-sugar manufactories divided for a series of years dividends to the extent of 60, 70, 90, and in one instance 125 per cent per annum on the capital invested;* and corresponding results were also reported in Austria, Russia, France, and Belgium. How rapidly and extensively sugar has declined in price, consequent upon such an extraordinary and unnatural increase in production, has already been

* "By a law passed in 1869 it was assumed that it took 12½ centners of beet-roots to give one centner of crude sugar, and a tax was levied on this basis, and a corresponding drawback allowed on exported sugar. Since then great improvements have been made in the process of manufacturing, so that but 10½ centners of roots are necessary to produce one centner of sugar instead of 12½ as formerly; but the Government continued to grant a drawback on the basis of 12½. The export drawback thus became an enormous premium to the producers, and the German manufacturers have been enabled to supply all Europe with cheap sugar; till, to protect themselves, the other states have had to increase their duties on the imports of foreign sugar."—*Report to United States Department of State by Commercial Agent* SMITH, *Mayence, January, 1887.*

pointed out. How much of disaster this decline has brought to great business interests and to the material prosperity, and even the civilization, of large areas of the earth's surface, will be made a subject of future notice.

WHEAT.—The next important commodity to the recent production and price experiences of which attention will be asked, is wheat. The average price of British wheat for the last week in July, 1882, was 50*s.* per imperial quarter. For the corresponding dates for 1885 it was 32*s.* 11*d.*, and for 1886, 31*s.* 3*d.* per quarter ; * which last quotation was the lowest since average market prices have been officially recorded. †

The average price of wheat in the English markets for the decade from 1870 to 1880 was 43 per cent higher than the average of 1886 ; and the average prices from 1859 to 1872 were 68 per cent higher than the average of 1886.

An analysis of the comparative prices of wheat in the United States furnishes corresponding results ; the average price of No. 2 spring wheat having declined in the Chicago market from $1.10 (gold) in 1872 to 76¼ cents in 1886 ; and 67 cents in July, 1887 ; a price equivalent to 29*s.* per quarter in the harbor at Liverpool, or 86 cents per bushel, cost, freight, insurance included. This is about the lowest price ever reported. The average annual export price of wheat for the whole country declined from $1.24 per bushel, in 1880, to 86·2 in 1885, and 87 in 1886. The average price of wheat in Chicago from 1872–'78 was $1.04 gold ; and the decline to the average price of 1886 was about 28 cents, representing a loss to the American producers of wheat on an average crop of at least $150,000,000 per annum. For such results an all-sufficient explanation would seem to be found in the circumstance, that all investigation shows that the comparatively recent increase in the world's supply of food has been greatly in excess of the concurrent increase of the world's population ; that there has been in the last decade a large increase in the area of land devoted to the cultivation of cereals ; an increase (due to better methods of tillage) in the average product per acre ; and an immense increase in the facilities for transportation, coupled with a greatly reduced cost, which has made product more accessible and accordingly more available for distribution. The most salient points of the evidence tending to these conclusions are as follows : The cereal production of the United States increased from 932,752,000 bushels in 1862 to 2,992,881,000 in 1884 ; and in acreage from 34,594,381 to 136,292,766 ; or in the respective ratios of 452 and 338 per cent, respectively. The average wheat production of the United States for the five years from

* London "Economist."

† The Eton record gave only 26*s.* 9½*d.* per quarter as the price for the year 1761, when reduced to Winchester bushels ; but there is no certainty that the average for the entire year was even in that one market as low as that, and still less that the price was as low in more than one hundred and fifty English market towns as it was in 1886.

1881 to 1885, inclusive, was 436,000,000 bushels; while for the ten years preceding—some of which supplied the heaviest demands for exportation ever experienced—the average was only 366,000,000 bushels. According to Mr. Neumann Spallart, a German statistician of repute, the production of cereals in Europe doubled from 1869 to 1879; and in the case of Russia, her exports of wheat increased from 36,565,000 bushels in 1880 to 67,717,000 in 1884. According to figures of the United States Bureau of Agriculture, the average production of wheat in Europe, for the five years from 1875 to 1881, inclusive, "increased some 50,000,000 bushels over the average of the ten years preceding, which included several seasons of unusually low yield in Western Europe." In 1862 the United States exported breadstuffs to the value of $24,000,000; in 1872 the corresponding value was $87,000,000; and in 1880, $288,000,000; and if since this latter year there has been a decline in the *value* of American cereal exports, it can not be attributed to any impairment of ability to produce and export, if sufficient inducements existed. Of the respective wheat-crops of the United States for the years 1884–'86, 30 per cent—in the form of wheat and flour—have been exported, the largest proportion ever recorded, except during the era of crop failures in Western Europe—i. e., 1878–1883. While, therefore, it is clear that the comparative product of the heretofore great wheat-producing countries has not diminished, recent experiences are also making it evident that the world is hereafter to derive important supplies of wheat from sources which a few years ago did not exist, or were regarded as of little importance. For example, British India, which in 1880 exported only 13,896,000 bushels, in 1885 exported 39,312,000 bushels, and whose increase of wheat exports appears to be coincident with the increase of the railway mileage of the country. During the same period Australia and New Zealand, where a rapid growth of population inevitably tends to divert agricultural industry from wool-producing to wheat-growing, increased their exports from 13,999,000 bushels in 1880 to 19,466,000 in 1885; and the Argentine Republic, from 5,772 bushels in 1881 to 3,986,000 in 1884. All the indications are, furthermore, that the increase of wheat supplies from new sources is likely to be continuous and of great magnitude: from India, whose internal and foreign commerce is yet only in its infancy, but is developing with extraordinary rapidity under the influence of railroad construction;* from the great wheat region of Manitoba, to

* "There is nothing more remarkable in the history of railway enterprise than the development of the traffic that has occurred on Indian railways within the last ten years, to go no farther back. In 1876 the total quantity of goods-traffic carried on all the railways of India was 5,750,000 tons. In 1886 the quantity was about 19,000,000 tons. In the year 1876 the mileage open was 6,833 miles, so that the volume of goods-traffic carried per mile was about 800 tons. In 1886 the mileage open was 12,376, so that the average volume of traffic carried per mile was over 1,500 tons. The aggregate volume of traffic in the interval had fully trebled, and the average traffic carried per mile open

open which the Canadian Pacific railroad was mainly constructed; from Algeria and Northern Africa, which, once the granaries of the Roman world, are now, for the first time for centuries, contributing something to the world's surplus of cereals; and from the South American states of the Argentine Republic and Chili, where extraordinary railroad construction is rapidly drawing an extraordinary European immigration to the finest of wheat-lands, which so recently as 1880 were practically inaccessible. Great, also, as is the present wheat product of the United States, Mr. Atkinson has shown that all the land at present in actual use in that whole country for growing maize or Indian corn, wheat, hay, oats, and cotton is only 272,000 square miles, out of 1,500,000 miles of arable land embraced in its present national domain; and, also, that the present entire wheat-crop of the United States could be grown on wheat-land of the best quality selected from that part of the area of the State of Texas by which that single State exceeds the present area of the German Empire.

In short, it would seem as if the world in general, for the first time in its history, had now good and sufficient reasons for feeling free from all apprehensions of a scarcity or dearness of bread. But while this is certainly a matter for congratulation, are there not, on the other hand, reasons for apprehension of serious disturbances to the material interests of that large part of the world's population engaged in agriculture, from the continued abundant production and decline in the price of their products?

The effect of the extensive fall in prices of agricultural products during the last decade has, as already pointed out, been most disastrous to the agricultural interests and population of Europe. It has reduced farming in England and Germany to the lowest stage of vitality, and has had less but similar effects in France, Italy, and Belgium. It has almost bankrupted the sugar-producing interests in the West Indies and the Dutch East Indies, and threatens the continuance of productive industries, and even of civilization, in these countries.* In 1880, 44

had almost doubled. Notwithstanding these remarkable results, the traffic which has been developed on the railways of India is less, in proportion to the population, than that of any country in the world. This is especially the case in reference to goods-traffic, which only represents some 0·05 of a ton per head of the population, as compared with three tons per head in Canada, and over seven tons per capita in the United Kingdom. But the goods-traffic of India is likely to develop very rapidly in the future, and especially in agricultural produce, of which only about 4,000,000 tons are now annually transported, as compared with 75,000,000 tons in the United States for less than a fourth of the population."—*Bradstreet's (N. Y.) Journal.*

* "In consequence of the low prices of sugar in Europe and America, owners of plantations and their lessees have speculated to such an extent that they have placed themselves on the brink of an abyss, and it is feared that this will totally stop the production of sugar in Java. This event would be in every way a great catastrophe. It would at once throw half a million of Javanese laborers out of employment, who would increase the already enormous number of Malay pirates."—*Journal des Fabricants de Sucre, October, 1886.*

per cent of the entire population of the United States was engaged in agriculture, and less than 7 per cent in manufactures; and since the year 1820, or for a period of sixty-six years, the proportion between the agricultural and non-agricultural exports of this country has been remarkably steady, the average for the former for the whole of this period having been about 78 per cent. Up to the present time there has been little tendency to change in these proportions; but, if the continued fall of prices of agricultural products in the United States and other countries should compel their farming populations to seek other employments, what other employments are open to them? That the world will ultimately adjust itself to all new conditions may not be doubted; but what of the period pending adjustment?*

* A recent writer in the (British) "Quarterly Review" broadly antagonizes the views above expressed respecting the prospective increasing production and continued low prices for wheat, and endeavors to prove that "it has been too hastily assumed that, in the struggle for existence among wheat-growers, the British, the best farmers in the world, will not be among the fittest who will survive." In support of this conclusion the writer starts with the proposition that the returns of the cost of growing wheat in Great Britain, collected in 1885, make the average about £8 ($40) per acre, and venturing the opinion that, with the general reduction of the rents of British farming-lands that have already taken place, and the practice of increased economies on the part of British farmers, they can grow wheat with a profit at 40*s.* and 45*s.* a quarter (although the average price of British wheat has not for some years reached that level), next assumes, that growers "in all parts of the world—with the doubtful exception of India—can not possibly keep up the present acreage of wheat at the recent or any lower range of prices." The writer further concludes, from an examination of American statistics, which he abundantly offers, that the area of wheat acreage in the United States is diminishing, and that the average farm-value of wheat in that country, for the years 1884–'86, was about 33*s.*, "which can not," he says, "yield a satisfactory profit under the most favorable circumstances."

The following reply to the conclusions of this writer in the "Quarterly," so far as they relate to the United States, which appeared in the columns of the "New York Commercial Bulletin" (May, 1887), strikingly illustrates how different the situation appears to a writer equally competent to discuss the question, when viewed from a trans-Atlantic standpoint:

"These guesses about the cost of wheat-producing in this country are highly interesting. Probably they will interest no one else so much as the American farmers, who know that they do not know, and have a strong impression that other people can not tell them, the exact cost of raising wheat per acre. Very few of them produce any one crop under such circumstances that they can accurately compute, in dollars or days' labor, what that separate crop costs them; and fewer still know what they add to the value of their land by improvements, or take from it by exhaustion yearly. But one thing a great many of them do know, that they are going to raise more wheat next year than they did last, as they raised more last year than the year before; and they have been selling wheat for several years at about 45 cents per bushel, in great regions like Kansas, Minnesota, and Dakota, and yet the business is found so far profitable that the acreage in these very States enormously increases. It is supposed that Dakota, which produced 22,800,000 in 1880, and 22,000,000 bushels three years ago, will produce 30,000,000 in 1887."

(In 1880 the crop area of the State of Kansas was about 8,000,000 acres; for the present year (1887) the area planted is believed to be in excess of 16,000,000 acres.)

"The farmer in this country is, at the same time, a land-improver and a land-speculator, in most of the great wheat-growing States. He takes possession of a farm under the homestead law, by pre-emption, or by purchase from corporations, the land costing

MEATS.—The price of meats, according to the statistics of English markets, exhibits no material decline, comparing the average prices of 1867–'77 and of 1878–'85. But during the years 1885 and 1886 the decline was very considerable, and extended also to most other animal products. The percentage of fall in the carcass prices of different kinds and quantities of meat in London, as given by the London "Economist" of November 27, 1885, was, in comparison with the prices for 1879, as follows: For inferior beef, 43 per cent; prime beef, 18 per cent; prime mutton, 13 per cent; large pork, 22 per cent; middling mutton, 27 per cent.

The immediate cause of this decline was undoubtedly the new sources of supply of live animals and fresh meats that have been opened up to Europe, and especially to Great Britain, from other than European countries: the value of the imports into Great Britain from North America of live animals having increased from $1,085,000 in 1876 to $22,980,000 in 1885; of fresh meat from $1,950,000 to $11,820,000; and of fresh meat from Australia and the River Plate (transported through refrigeration) from $890,000 in 1882 to $5,850,000 in 1885; a total increase of from $3,025,000 in 1870 to $40,650,000 in 1885. The ability of the three countries named to increase their exports of meat during such a brief period to such an enormous extent, constitutes of itself a demonstration of increased product and of the diminished price that is the invariable accompaniment of a surplus seeking a market. The decline in the average export price of salt beef in the United States was from 8·2 cents per pound in 1884 to 6 cents in 1886 (26 per cent); of salt pork from 8·2 cents to 5·9 cents

him so little that a single good crop or two pays for it outright. Then he puts into it labor of his own, and of men hired, which he could not otherwise utilize at all, and the cost of which he can not compute, and thus adds year after year to its value. The farmer who runs into debt can tell what his land costs him yearly, but they are not the majority. Most farmers get a living out of the land for themselves and families, to begin with, and make some improvements besides, and meanwhile are gaining more without any effort, than by all their labor. For, while the farmer is raising four or five crops, a settled State or county grows up about him. Towns and cities start from the ground. Railroads and manufacturing establishments come to enhance the value of his land. In a few years, the ground that he bought for $1.25 to $5 per acre comes to be worth in market price $10, $20, or $30 per acre. Land settled by men who are yet in their prime averages in value over $26 per acre for the entire State of Iowa, or $13 for the entire State of Minnesota, or $10 for the entire States of Kansas and Nebraska. That means for the owners of only a small farm a yearly saving which not many wage-earners are able to accomplish, and in all the more successful selections of land the increase in value and the consequent return for labor are far greater.

"Just as long as this occupation of new land and development of new territory are possible in this country, the most scientific calculation of the cost of growing wheat will have as much to do with its continued production or with its average price as it has to do with the height of mountains in the moon. Wheat-growing will continue, and the yield in this country will greatly exceed the demand, and an enormous surplus will be annually offered for sale, at prices with which British farmers can not easily compete, where the cost of growing wheat averages 'about $40 per acre.'"

(27 per cent); of bacon and hams from 9·6 cents to 7·5 cents; and of lard from 9·4 cents to 6·9 cents. In the case of lard-oil an exceptionally great decline in price in recent years—i. e., from an average of 94 cents per gallon (Cincinnati market) in 1881–'82 to a minimum of 48·8 cents in 1886, is claimed to be due mainly to the large production and more general use of vegetable oils—cotton-seed oil in the United States, and palm and cocoanut oils in Europe. The effect of the increased quantity and cheapness of these vegetable oils has been especially marked in England, France, Italy, and Germany; and has also undoubtedly influenced the price of tallow, the decline in which in English markets, comparing the average prices of 1867–'77 with those of 1886, having been 31 per cent, while in the United States the price for 1884–'85 was the lowest on record.

CHEESE.—American cheese experienced an extraordinary decline in price from 12 and 13 cents in 1880 to 8⅜ and 10½ cents in 1885; and as the American contribution of this article of food to the world's consumption has constituted in recent years a large factor, the world's prices generally corresponded with those of the American market. This decline in the United States was due mainly to increased product; the relative prices of butter and cheese during the years 1880–'81 being so much to the advantage of the latter, that large quantities of milk which had previously gone to the creameries to be made into butter, found their way into factories to be made into cheese; and for the years 1883, 1884, and 1885 the annual receipts at New York city averaged 25 per cent in excess of the receipts for 1880. Demand for export at the same time largely fell off, and so assisted in the decline of prices; the same influences existing in the United States having also apparently prevailed to a degree in other cheese-producing countries, the amount recognized by the trade as supplied to the great cheese-consuming countries, Great Britain, the Continent of Europe, and South America, having increased from 1880 to 1884 to the extent of 14 per cent.

FISH.—The year 1884 in the United States was notable for a plethora of all kinds of dry and pickled fish on the one hand, and of extreme low prices of such commodities on the other; mackerel having touched a lower price in the Boston market than for any year since 1849, while for codfish the price was less than at any time since the year 1838.

COFFEE AND TEA.—The decline in recent years in the prices of each of these great staple commodities has been almost as remarkable as has been the case with sugar, coffee having touched the lowest prices ever known in commerce in the early months of 1886, the price of "ordinary," or "exchange standard No. 5," having been 7¼ cents per pound in January of that year in the New York market; while, according to Mr. Giffen, of the British Board of Trade, the decline in the price of tea, comparing 1882 with 1861, has been greater than that of sugar,

or, indeed, of almost any other article. In both cases the decline would seem to find a sufficient explanation in a common expression of the trade circulars, "Our supplies have far outrun our consumptive requirements." In the case of coffee, the total imports into Europe and the United States, comparing the receipts of the year 1885 with 1873, showed an increase of 57 per cent; while the increase in the crops of Brazil, Ceylon, and Java during the same period has been estimated at 52 per cent. Subsequent to January, 1886, the price of coffee, owing to a partial failure of the Brazil crop, rapidly advanced more than 150 per cent, "ordinary" or "exchange" standards having sold in New York in June, 1886, at 22 cents per pound, the highest point in the history of American trade, unless possibly during the war, when entirely abnormal circumstances controlled prices. From these high prices there was a subsequent disastrous reaction and extensive failures. In the matter of the supply of tea, the total exports from China and India increased from 234,000,000 pounds in 1873 to 337,000,000 pounds in 1885, or 44 per cent; the exports from India having increased from 35,000,000 pounds in 1879 to 68,000,000 pounds in 1885.*

Hops.—The report of the German Hop-Growers' Association for 1886 estimates the quantity grown throughout the world in that year at 93,340 tons, and the annual consumption at only 83,200 tons, so that there was an excess of production over consumption in 1886 of nearly 10,000 tons. As might have been expected, there was a notable decline in the world's prices for hops.

Such having been the production and price experience in recent years of the world's great food commodities, attention is next invited to a similar record of experience in respect to the metals.

Iron.—Sir Lowthian Bell, recognized as one of the best authorities on the production of iron and steel, in his testimony before the Royal British Commission in 1885, fixed the world's production of pig-iron in 1870 at 11,565,000 tons, which increased to 14,345,000 tons in 1872. From that date production continued almost stationary until 1879,

* The British Chancellor of the Exchequer, Mr. Goschen, in his budget speech for 1887, calls attention to the following curious incident of financial disturbance growing out of a change in the quality of a staple commodity—tea—which, in turn, has been contingent on a change in the locality or country of its production: "Whereas, ten years ago," he said, "we (Great Britain) received 156,000,000 pounds of tea from China and 28,000,000 pounds from India, or 184,000,000 pounds altogether, in 1886 we received 145,000,000 pounds from China and 81,000,000 pounds from India. In the transfer of consumption of tea from the tea of China to that of India, we have to put up with a loss of revenue owing to the curious fact that the teas of India are stronger than the teas of China, and therefore go further, so that a smaller quantity of tea is required to make the same number of cups of tea." Mr. Goschen further called attention to the fact that "the fall in the price of tea and sugar (in Great Britain) has been so great, that whereas in 1866 a pound of tea and a pound of sugar would have cost 2*s.* 6*d.* and in 1876 2*s.* 1¼*d.*, in 1886 they would have cost only 1*s.* 7¼*d.*, or 3*d.* less than they would have cost in 1866 with all the duties taken off."

when it was 14,048,000 tons. "After 1879 an extraordinary change became apparent in the volume of the make, for during the ensuing five years the average make was 18,000,000 tons, and in 1883 it rose to 21,063,000, or nearly 50 per cent more than it was in 1879." The witness further estimated that while the product of iron increased in the United Kingdom at the rate of 131 per cent from 1870 to 1884, the increase in the production of the rest of the world during the same period had been 237 per cent.

The tables of the American Iron and Steel Association, prepared by Mr. James M. Swank, indicate an increase in the pig-iron product of the world, from 1870 to 1886 inclusive, of about 100 per cent. All authorities are therefore substantially agreed that the increase in the production of this commodity in recent years has been not only far in excess of the increase of the world's population in general, but also of the increase of the population of the principal iron-producing countries. Thus, for example, in the United States, the production increased from 4,044,526 gross tons in 1885 to 5,683,329 in 1886, an increase of 1,638,803 tons, or 40 per cent.

Under such circumstances, the price of pig-iron throughout the world has rapidly declined, and in the case of some varieties touched in 1885–'86 the lowest points in the history of the trade. American pig, which sold in February, 1880, for $45 per ton, declined almost continuously until September, 1885, when the low point of $16⅝ was reached; while in Great Britain, Cleveland pig, which sold for £4 17*s.* 1*d.* in 1872, and £2 5*s.* in 1880, declined to £1 10*s.* 9*d.* in 1886. The decline in Bessemer steel rails in the English market was from £12 1*s.* 1*d.* in 1874 to less than £4 in 1887. In the United States, Bessemer steel rails, which commanded $58 per ton at the mills in 1880, fell to $28.25 at the close of the year 1884, reacting to $39½ in March, 1887.

Reviewing, specifically, the causes which have contributed to the above-noted extraordinary decline in the prices of iron, the following points are worthy of notice:

First. The testimony of Sir Lowthian Bell shows that foreign countries have within recent years, and contrary to former experience, increased their production of iron in a far greater ratio than Great Britain, which was formerly the chief factor in the world's supply; and, in consequence, have become formidable competitors with Great Britain, not only in their own territories, but also in neutral markets. New fields of iron-ore have been discovered in Germany, France, and Belgium, very analogous in point of character to those which by discovery and development, about the year 1850, in the north of England, led to the subsequent great and rapid increase of British iron production.

Second. The power of producing iron with a given amount of labor and capital has, in recent years, greatly increased. For example, the

average product per man of the furnaces of Great Britain, which for 1870 was estimated at 173 tons, is reported to have been 194 tons in 1880, and 261 tons in 1884.

Third. The substitution of steel for iron has resulted in a notable diminution of the consumption of iron for the attainment of a given result, or, in other words, more work is attainable from a less weight of material. Sir Lowthian Bell, in his testimony before the Royal British Commission, stated that a ship of 1,700 tons requires 17 per cent less in weight of pig-iron, in being built of steel rather than of iron, and is capable of doing 7 per cent more work.

Again, the quantity of pig-iron requisite for keeping a railroad in repair will depend greatly upon the state in which iron enters into construction; rails of steel, for example, having a far greater durability than rails of iron.*

A further example of recent economic disturbance consequent upon changes in the manufacture of iron—characterized by the Secretary of the British Iron Trade Association, in his report for 1886, as "one of the most remarkable of modern times"—is to be found in the rapid disuse of the system invented about one hundred years ago by Henry Cort for converting pig-iron into malleable iron by the so-called process of "puddling." Twenty years ago the use of this process was almost universal, to-day it is almost a thing that has past; and the loss of British capital invested in puddling-furnaces which have been abandoned in the ten years from 1875 to 1885, is estimated to have approximated £4,667,000, or $23,333,000, involving in Great Britain alone a displacement, or transfer of workmen to other branches of industry during the same period of about 39,000.

Copper.—This metal touched the lowest price on record in 1886, Lake Superior copper in New York falling from 25 cents per pound

* Opinions, as yet, vary greatly as to the comparative durability of iron and steel rails. In the testimony given before the British Royal Commission, Mr. I. T. Smith, manager of the Barrow Steel Company, gave it as his opinion that the life of a steel rail is three times that of an iron rail, adding, "My reason for saying so is, that I know that upon the London and Northwestern Railroad, where steel rails have been now in use more than twenty years, they consider it so."

Sir Lowthian Bell also, in testifying before the commission, on the effect on the iron-trade of Great Britain from the expected longer duration of steel rails, says: "Assuming iron rails to last twelve, and steel rails twenty-four years, instead of the railways now in existence in the United Kingdom requiring 465,648 tons annually for repairs, 232,824 tons will suffice for the purpose. Although this only involves the saving of a comparatively small weight of pig-iron, it means less work for remelting and for our rolling-mills, say to the extent of 4,000 to 5,000 tons per week." The difference in duration of iron and steel rails is not, however, in itself a complete measure of the amount of pig-iron required for renewals. This arises from the fact that an iron rail splits up and becomes useless long before the actual wear, as measured by the diminution of weight, renders it unsafe, which often happens when the loss of weight does not exceed 4 per cent of the original weight. Steel rails, on the other hand, go on losing weight until they are from 10 to 20 per cent lighter than when they were laid down, before becoming unsafe.

in 1880 to 9½ cents in August, 1886; and in the case of no other single commodity is the connection between the decline in price and the increase of production so well established and so significant. The increase in the copper product of the world is estimated by Mr. Sauerbeck to have been 97 per cent in the thirteen years from 1873 to 1885, inclusive; while according to the report of the United States Geological Survey, 1886, the increase from 1879 to 1885 was nearly 47 per cent (46·8). The countries which have most notably contributed to this increased product have been the United States, Spain, and Portugal; the increase in the case of the former having been from 23,000 tons in 1879 to 74,053 tons in 1885; and in that of the latter, from 32,677 tons to 45,749 in the same period. As in all other like cases, the disturbing effect on the industries involved—mining and smelting—contingent on this rapid and remarkable fall of prices, was very great, and in all quarters of the world. In Montana, the Montana Copper Company, with an annual product of 8,000,000 pounds of pure copper, entirely suspended operations; and the Anaconda Company, with an annual product of 36,000,000 pounds, shut down 20 out of 28 furnaces, and discharged most of its hands at the mine. In Chili, production during the year 1885 was diminished to the extent of about 10 per cent. In Germany the great Mansfield mine, which reported gross profits in 1884 of 5,675,000 marks, sustained a loss in the operation of 1885 of 653,338 marks; and its managers have since sought relief by petitioning the Imperial Government for the imposition of a higher tariff on the imports of copper into the empire. For the years 1881–'83 the great San Domingo mine in Portugal paid annual dividends of 12½ per cent; in 1885 the annual rate was reduced to 3¾ per cent. It is important also to note, as throwing light upon the problem of the recent reduction of prices, that while in the case of copper the increase of product has been confessedly immense, three other agencies—one permanent, and the other two of a temporary character—have contributed to its recent decline in price. The *first* is, that there has been a reduction in the cost of mining, smelting, and marketing copper at the principal mines of the world, owing to improved processes, and reduced rates of transportation contingent on railroad construction. In the case of the Lake Superior mines, this reduction is very striking; in the "Quincy" mine, for example, the cost of production in cents per pound having been reduced from 10·03 in 1881, to 7·50 in 1885; and in the "Atlantic" from 13·80 to 9·37 in the corresponding period. *Second.* The recent discovery and rapid development of new and rich mines in Montana, Arizona, the Dominion of Canada, and elsewhere, have left a feeling of apprehension in the world's market as to the conditions of the supply of this metal in the future. *Third.* The consumption of copper in Europe, for the year 1886, fell off 14,000 tons below the average for the two preceding years—a result attributed mainly to the dullness of ship-building, and the various metal industries.

LEAD experienced a decline, comparing the highest market prices in New York, in January, 1880 and 1885, respectively, of about 39 per cent; or, comparing the average of prices for New York and London for the same years, about 30 per cent. The world's production of lead between the years 1880 and 1883 appears to have increased in nearly the same ratio, or far in excess of the increase of the world's population within the same period. With an approaching exhaustion of a number of the heaviest lead-producing mines in the Rocky Mountains, United States,* and a notable decline in the lead product of British ores (50,328 tons in 1882 as compared with 37,687 tons in 1885), the price of lead tends to increase. The decline in the price of lead, above noted, occasioned the suspension or bankruptcy of many English lead-mining companies, and during the year 1885 much distress from this cause was reported as existing among English lead-miners. The following is an example of another economic disturbance contingent on changes in the production and price of lead: Formerly the domestic supply in the United States of white-lead and of all paints, the basis of which is oxide of lead, was derived almost exclusively from manufactories situated upon the Atlantic seaboard; but with the discovery and working of the so-called silver-lead mines of the States and Territories west of the Mississippi, and the production of large quantities of lead as a product residual, or secondary to silver, the inducements offered for the manufacture of white-lead and lead-paints, through local reductions in the price of the raw material and the saving of freights, have been almost sufficient to destroy the former extensive white-lead and paint business in the eastern sections of the United States, and transfer it to the western.

NICKEL, not many years ago, was a scarce metal of limited uses, and commanded comparatively high prices. Latterly the discovery of new and cheaper sources of supply has tended to throw upon the market an amount in excess of the world's present average yearly consumption—estimated at between 800 and 900 tons—and, as a consequence, there has been "over-production, and unsatisfactory prices to dealers." There is, moreover, little prospect that prices in respect to this metal will ever revive—one mine in New Caledonia alone being estimated as capable of producing two or three thousand tons annually, if required; while the discovery of richer and more abundant ore deposits than have ever before been known is reported as having resulted from the construction of the Canadian Pacific Railroad.

TIN.—The production and price experiences of this metal during the last quarter of a century have been very curious. The world's consumption of tin from 1860–'64 constantly tended to be in excess of production, and prices rose from £87 (the lowest figure) in 1864 to £159 (the highest) in 1872. In this latter year the mines of Australia began to produce very largely, and in a short time afforded a

* Report of the United States Geological Survey, 1886.

supply equal to one third of the world's current consumption. Under such circumstances the price of tin rapidly declined, and in October, 1878, touched £52 10*s.*, the lowest price ever known in history; a decline of 66 per cent. For some years past, however, the product of tin in Australia has been declining, that of the "Straits" increasing, and that of England and other countries remaining nearly stationary. But the consumption of tin throughout the world has gone on continually increasing, until now the surplus stock is being so rapidly reduced, that unless new sources of supply are developed, famine rates may again occur; prices having advanced continuously from £52 10*s.* in 1879 to £107 in June, 1887.

TIN PLATES.—Owing to a well-recognized tendency of consumption to exceed production, tin plates in common with tin ruled at what were termed "famine" prices in 1872, and for some years previous; the average price for "coke" plates being from 26*s.* to 27*s.* per ton. Since 1872 the decline has been in excess of 50 per cent—the quotations for the first half of the year 1887 having been from 12*s.* 6*d.* to 13*s.* per box. This remarkable and steady decline in the prices of this commodity during the last fifteen years, is as clearly and certainly understood as in the case of tin, above noticed; and is referable to three causes: *First*, the reduction in the cost of the metal tin. *Second*, to the revolution in the manufacture of iron, and the extensive substitution of steel (plates) in place of charcoal and puddled iron plates. *Third*, to new processes of manufacture and tinning; a modern tin-plate mill turning out every twenty-four hours more than double the product of old-fashioned mills, without any increase in expenditure for motive power or labor. Supply and consumption alike under such circumstances have increased to an enormous extent, and the tin-plate trade, instead of being a minor industry of the world, as was formerly and not remotely the case, has become one of great magnitude. The decline in prices has, however, brought nothing of prosperity to the British tin-plate manufacturing industry; as out of an average of eighty-two works in existence during recent years in South Wales, there have been no less than forty failures.*

QUICKSILVER.—Excepting petroleum and quinine, the decline in price of this metal seems to have been greater in recent years than

* An attempt on the part of Germany to break in upon the almost complete monopoly of the manufacture of tin plates enjoyed by Great Britain, by imposing a heavy duty on their importation, has been singularly unsuccessful; domestic (German) production and exports having diminished, and exports increased, as will appear from the following table:

YEAR.	Production, tons.	Imports, tons.	Exports, tons.
1885.....	4,892	5,798	186
1878.....	8,582	5,307	1,696

that of any other leading commodity—i. e., from £26 per flask (the highest) on the London market, in 1874, to £5 2*s.* 6*d.* (lowest) in 1884; and from $118 (highest) to $26 (lowest) on the San Francisco market during the same period—a decline of 77·1 per cent. The explanation of this movement of price is to be found mainly in the circumstance that California, which furnishes nearly one half of the world's supply of this metal, increased her production from 30,077 flasks in 1870 to 79,684 in 1877; and although, as the result of low prices, only ten of thirty working mines of California were in operation in 1885 (none of which paid a dividend in that year), the generally increased supply of quicksilver, coupled with its diminished use in the reduction of silver-ores—consequent on the introduction and use of cheaper processes—has thus far prevented any material augmentation in its price, the London quotation for June, 1887, having been £6 15*s.* per flask.

Silver.—The annual supply of silver from the mines of the world has largely increased since 1872–'73, the period covered by the marked decline in the market price of silver, or from $65,000,000 in 1872 to $102,168,000 in 1881; $115,000,000 in 1883, and $124,000,000 in 1885—an increase in supply in fourteen years of 90·7 per cent.*

Coal.—The decline in the export prices of British coal, comparing the average for 1867–'77 with 1886, was about 33 per cent. The decline in the average annual price of anthracite coal (by the cargo at Philadelphia), comparing 1870 with 1880, was 38 per cent; but, as between 1870 and 1886, it was only 6·6 per cent. The total production of all kinds of coal in the United States in 1886, according to the returns of the United States Geological Survey, shows a net gain of 1,785,000 short tons, as compared with 1885, but a loss in value at the point of production of $4,419,420.

The increase in the product of the five chief coal-producing countries of the world, Great Britain, the United States, Germany, France, and Belgium, from 1870 to 1886 inclusive, has been in excess of 80 per cent—Great Britain increasing her product from 109,000,000 tons in 1870 to 159,351,000 in 1885; and the United States from 38,468,000 in 1870 to 112,743,000 short tons in 1886. On the other hand, the amount of coal displaced from use in the United States in 1886 by the introduction and use of natural gas is estimated by the United States Geological Survey at 6,353,000 tons, valued at $9,847,000. In Germany, the increase reported was from 36,041,000 tons in 1873 to 55,000,000 tons in 1883. In 1870 the average output of coal per miner in the British coal-mines—counting in all the men employed—was 250 tons, an amount never before reached. In 1879 this average had increased to 280 tons per man, and in 1884 the average for the five preceding years was reported at 322 tons, an increase of 42 gross tons of 21 cwt.

* The estimates of the annual silver production of the world, submitted to the Royal (British) Commission on Gold and Silver by Mr. Hector Hay, are somewhat smaller, namely, £12.8 in 1873; £18.8 in 1881; £20.6 in 1883; and £21.3 in 1885.

per man per annum. For Germany, the increase was from 261 tons in 1881 to 269 tons in 1883; and in Belgium, for corresponding years, from 165 tons to 178 tons per miner.

Recent inventions have also done much to reduce the amount of coal formerly used to effect industrial results, particularly in the case of blast-furnaces and coke-ovens. For example, at blast-furnaces, coal was formerly used for heating the boilers that furnished steam for blowing, hoisting, etc., and for heating the air which was blown into the stacks. Now, a well-ordered set of blast-furnaces does not use a single ounce of coal except what goes in to melt the ore. The whole of the heat used to produce the steam required in connection with the furnace, and for heating the stoves for making the hot blast, is obtained from the gases which rise to the top of the stacks in the process of smelting the iron, and which formerly was all thrown away.*

PETROLEUM.—Crude petroleum declined in the American market from an average of $3.86 (gold) per barrel in 1870 to 87½ cents per barrel in 1885, and 71½ cents in 1886, a total decline of over 80 per cent.

The American annual production (including Canada) increased during the same period from 5,510,745 barrels in 1870 to 30,626,100 in 1882, declining to 25,798,000 in 1886.

That the production and price experiences of the great staple fibers of commerce and consumption in recent years have not been dissimilar to those of the foods and metals, will also appear from the following:

COTTON.—Comparing 1860 with 1885, the decline in the price of American cotton (middling uplands) in the New York market has not been material. The year 1886, however, witnessed a decline to a lower point (8 1/16) than has been reached, with one exception, since the year 1855; the exception occurring just after the failure of the Glasgow Bank in Scotland in 1878, the lowest quotations in both years being exactly the same. On the other hand, the increase in the world's supply of cotton in recent years has been very considerable, the American crop increasing from 3,930,000 bales in 1872–'73 to 6,575,000 in 1885–'86, or 67 per cent; while the supply of the world for the corresponding period is estimated to have increased from 6,524,000 bales to 8,678,000 bales, or at the rate of about 32 per cent. Such an increase in production would undoubtedly have occasioned a more marked decline in price, had it not been for a great and coincident increase in the world's consumption of cotton fabrics; which, in turn, was undoubtedly in consequence of a material decline in the cost of the same, as the result of improvements in machinery and methods of production; the equivalent of the labor of an operative in the factories of New England having increased from 12,164 yards in 1850 to 19,293 in 1870, and 28,032 in 1884, while the reduction in the price of

* Testimony of J. D. Ellis, chairman of John Brown & Co., Sheffield, British Commission, 1886.

standard sheetings from 1850 to 1885 has been about 10 per cent, and of standard prints and printing-cloths, during the same period, approximately 40 per cent.

Wool.—According to the statistics of Mr. Sauerbeck ("Journal of Statistical Society," March, 1887), the price of merino wool (Port Philip, Australia, average fleece), comparing the average of the series of years 1867–'77 and 1878–'85, declined 10·7 per cent; or, comparing the average price of 1867–'77 with that of the single year 1886, when wool "was cheaper than at any time within the memory of the present generation," 27 per cent. Certain fibers classed with wool, and known as "alpaca" and "mohair," and the grade of long-combing English wools known as "Lincoln," experienced a much greater decline after 1874–'75, owing to the curious circumstance that a change in fashion in those years almost entirely and suddenly destroyed any demand for the before popular, stiff, lustrous fabrics manufactured from such wools for female wear, and substituted in their place the soft and pliable cloths that are made from the merino wools.

The increase in the production and world's supply of raw wools, from the years 1860 to 1885 inclusive, was about 100 per cent. According to Mr. Sauerbeck's tables, the increase from 1873 to 1885 inclusive, was 20 per cent; according to Messrs. Helmuth, Schwartze & Co., of London, the increase from 1871–'75 to 1881–'85 was 23 per cent; and from 1871–'75 to 1886, 35 per cent. The wool-clip of the United States increased from 264,000,000 pounds in 1880 to 329,000,000 in 1885, or 24·6 per cent in six years. Such an increase in the world's supply of wool would undoubtedly have resulted in a greater decline in prices, had not the increase been accompanied, as was the case with cotton, with a very marked increase during the last quarter of a century in the world's consumption—i. e., from 2·03 pounds of clean wool per head in 1860 to 2·66 pounds in 1886.*

Silk.—The decline in the price of silk (Tsatlee), according to Mr. Sauerbeck, from the average price of 1867–'77 to the average of 1886, was about 40 per cent; and the average increase in supply of all varieties of silk-fiber, comparing 1873 with 1885, was reported by the same authority as about 12 per cent. No relation between the price movements of this commodity and supply and demand or any other agencies can, however, be established, which fails to take into account the great increase in the use of the ramie and other fibers and materials within recent years as substitutes for or adulterations of silk in the

* The details of this increase are thus stated by Messrs. Helmuth, Schwartze & Co., of London, in their annual review of the production and consumption of wool for 1887: "Making allowance," they say, "for the increase of population, we find that the principal development in the supply of wool took place from 1860 to 1868, in which period the consumption rose from 2·03 pounds of clean wool per head to 2·47 pounds, or about 22 per cent. From 1868 to 1879 the consumption remained practically unchanged, amounting on the average to 2·41 pounds clean wool per head. It rose to 2·49 pounds for the average of the next four years, and was 2·58 in 1884 and 2·66 pounds in 1886."

manufacture of fabrics, and which must obviously have an effect on the price of raw silk equivalent to an increase in its supply.

JUTE.—Good medium jute declined on the London market from £17 per ton in 1874 to an average of £11 10*s.* in 1886, or more than 32 per cent. The increase in exports from British India was from 5,206,570 cwt. in 1876 to 10,348,909 cwt. in 1883, or 98 per cent.

NITRATE OF SODA.—The recent price experiences of nitrate of soda (Chilian saltpeter) have been very curious. The supply of this article, which corresponds to the more valuable nitrate of potash (true saltpeter), is practically limited to one locality on the earth's surface —a rainless, desert tract—in the province of Tarapacá, which formerly belonged to Peru, but has recently been annexed to Chili. It is cheaply and plentifully obtained, at points from fifty to ninety miles from the coast, by dissolving out the nitrate salt from the desert earth, which it impregnates, with water, and concentrating the solution by boiling to the point where the nitrate separates by crystallization. Up to the year 1845 it was an article so little known to commerce, that only 6,000 tons were annually exported; but as its value as a fertilizing agent in agriculture, and as a cheap source of nitrogen in the manufacture of nitric acid, became recognized, the demand for it rapidly increased until the amount exported in 1883 was estimated at 570,000 tons, or more than a thousand million pounds. To meet this demand and obtain the profit resulting from substituting skillful for primitive methods of extracting and marketing the nitrate, foreign capital, mainly English, extensively engaged in the business. A large amount of English-made machinery, and many English engineers and mechanics, were sent out and planted in the desert; additional supplies of water were secured, and a railroad fifty-nine miles in length constructed to the port of Iquique on the sea-coast, for the transportation of coal, provisions, and other material *up*, and the nitrate as a return freight *down*. So energetically, moreover, was the work pressed, that at the last and most complete establishment constructed under English auspices, the business, employing when in full operation six hundred men, was prosecuted unremittingly by night (by the agency of the electric light) as well as by day. The result was exactly what might have been anticipated. The export of nitrate, which was 319,000 tons in 1881, rose to 570,000 tons in 1883; and prices at the close of 1883 declined with great rapidity to the extent of more than 50 per cent, or to a point claimed to be below the cost of production. Such a result, threatening the whole business with disaster, led to an agreement on the part of all the interests concerned, to limit from June, 1884, to January, 1887, the product of every establishment to 25 per cent of its capacity. But notwithstanding these well-devised measures, prices have not been restored to their former figures, the average price per cwt. in London having been 10*s.* in 1886, as compared with an average of 14*s.* for 1867–'77.

For May, 1887, the quotations had advanced to 11*s.* and 11*s.* 5*d.* This case is especially worthy of notice, because it constitutes another example of a great and rapid decline in the price of a standard and valuable commodity in the world's commerce, and for which—all the facts being clearly understood—it is not possible to assign any other cause than that of production in excess of any current demand for consumption, and which in turn has been solely contingent on the employment, under novel conditions, of improved methods for overcoming territorial and climatic difficulties.

Concurrently with the fall in the price of nitrate of soda, saltpeter, or nitrate of potash, also notably declined from 28*s.* 3*d.* in 1880 to 21*s.* in 1887 (for English refined), a fact which seems to find a sufficient explanation in the circumstance that nitrate of soda can be used to a certain extent as a substitute for nitrate of potash, and that the export of the latter from India, the country of chief supply, increased from 352,995 cwt. in 1881 to 451,917 cwt. in 1885, or 36 per cent.

PAPER.—A quarter of a century ago, or less, paper was made almost exclusively from the fibers of cotton and linen rags; and with an enormous and continually increasing demand, paper and rags not only rapidly increased in price, but continually tended to increase, and thus greatly stimulated effort for the discovery and utilization of new fibrous materials for the manufacture of paper. These efforts have been so eminently successful that immense quantities of pulp suitable for the manufacture of paper are now made from the fibers of wood, straw, and various grasses, and so cheaply that the prices of fair qualities of book-paper have declined since the year 1872 to the extent of fully 50 per cent, while in the case of ordinary "news" the decline has been even greater. Rags, although still extensively used, have, by the competitive supply of substitute materials, and a consequent comparative lack of demand, been also greatly cheapened.

QUININE.—But in no one article has the decline in recent years been more extraordinary and thoroughly capable of explanation than in the case of sulphate of quinine, a standard chemical preparation used extensively all over the world for medicinal purposes. In 1865 the highest price of sulphate of quinine in the English market was 4*s.* 4*d.* ($1.07) per ounce, which gradually advanced to 9*s.* 6*d.* in 1873, reacting to 6*s.* 9*d.* in 1876. In the subsequent year, owing to an interruption in the exportation of cinchona-bark from South America by civil war in New Granada, and by low water in the Magdalena River, the price advanced to the unprecedently high figure of 16*s.* 6*d.* ($4.70) per ounce, receding to 13*s.* in 1879, and 12*s.* in 1880. In 1883 identically the same article sold in Europe for 3*s.* 6*d.* per ounce, and in 1885 for 2*s.* 6*d.*, a result entirely attributable to the successful and extensive introduction and growth of the cinchona-tree in the British and Dutch East Indies, and to the further very curious circumstance that, while the cinchona-barks from South America—the product of

indigenous trees—yield on an average not over 2 per cent of quinine, the bark of the cultivated tree in Java is reported to yield from 8 to 12 per cent.

The decline in the prices of many chemicals, due to improvements in methods and to excess of production, has also been very great—the decline in soda-ash from 1872 having been 54 per cent, while bleaching-powders (chloride of lime) declined from £10 in 1873 to £6.15 in 1878, reacting to £9 in 1887.

Many other commodities, of greater or less importance, might be included in this investigation, with a deduction of like results; but a further exhibit is not necessary. For it is difficult to see how any one can rise from an examination of the record of the production and price experiences of the commodities which have been specified, which, it must be remembered, represent—considered either from the standpoint of qualities or values—the great bulk of the trade, commerce, and consumption of the world, without being abundantly and conclusively satisfied that the decline in their prices, which has occurred during the last ten or fifteen years, or from 1873, has been so largely due to conditions affecting their supply and demand, that if any or all other causes whatever have contributed to such a result, the influence exerted has not been appreciable; and further, that if the prices of all other commodities, not included in the above record, had confessedly been influenced by a scarcity of gold, the claims preferred by the advocates of the latter theory could not be fairly entitled to any more favorable verdict than that of "not proven."

But have all other commodities, for which conclusive evidence of a recent greatly-augmented production can not be adduced, exhibited in their recent price movements any evidence of having been subjected to any influences attributable to the scarcity of gold? For the consideration of this question, reference is made to the next paper of this series.

PROFESSOR N. S. SHALER advocates, in the "Popular Science News," a system of international co-operation in meteorological observation. We need it in order to obtain a wider field whence to draw data for forecasts, so that we may make them for longer periods; for the proper study of the "meteorological unit," which the whole North Atlantic basin constitutes; for the proper determination of the work and influence of the Gulf Stream and of the Pacific Current; for the investigation of variations of the sun's heat, the field of observation for which should cover nearly the whole earth; and for the study of extra-meteorological phenomena like earthquakes and earth-tremors. We can hardly determine what is of importance to the climates of Europe and America without a pretty thorough study of all the great climatal units of the earth. The seven nations, Great Britain, the United States, France, Germany, Russia, Spain, and Holland, with their colonies, are so situated that, with their co-operative action, no great area of the earth, except the polar regions and the central oceanic areas, need be without regular frequent observations in aid of these studies.

COLOR-BLINDNESS AMONG RAILROAD EMPLOYÉS.*

By WILLIAM THOMSON, M. D.,
PROFESSOR OF OPHTHALMOLOGY IN THE JEFFERSON MEDICAL COLLEGE OF PHILADELPHIA.

THE conflict between the officers and the employés of the Reading Railroad, with its forty-two thousand employés on three thousand miles of track, which has occupied recently the attention of the public, and has threatened to produce a suspension of work on that road, has reopened the question of color-blindness among railroad employés, and led to a full demonstration of its existence among those engaged even as engine-men, where the defect might lead to serious accidents, with loss of property and life. The officers of the road have selected the system for examination suggested by the writer, and employed to a full success for more than five years past on the Pennsylvania Railroad, and have appointed me to supervise its details, and, as ophthalmological expert, to decide all doubtful cases after careful examination of those found defective by the non-professional examiners of the company.

The conflict is nearly over, since demonstrations of the optical defect in engineers, made before a committee appointed by the employés have satisfied them of the propriety of the testing, and that the safety of the traveling public demands the removal of all color-blind persons from positions where their optical defect might be the cause of distressing accidents. In the recent demonstrations, I was able at my office to show that an engine-man declared a red danger-signal, made by placing red glass in front of a large gas-light at a distance of two feet away, to be a green light; he was also not only unable to distinguish a red from a green flag within six feet, but he failed to classify the flags, white, red, green, and blue, properly, even when allowed to take them in his own hands.

The system adopted by the Reading Railroad is the one in use on the Pennsylvania Railroad, and owes its value to the fact that large bodies of employés can be brought under inspection, and their defects discovered by non-professional examiners. It has been fully described in the "Medical News" of January 14, 1882, in the second edition of Nettleship's work on "Diseases of the Eye," and in a paper read before the American Association for the Advancement of Science, in September, 1884, and in "The Popular Science Monthly" for February, 1885, and to those sources the reader is referred for further information.

Previous to its adoption by the officers and directors of the Pennsylvania Railroad two thousand men were examined, and their blanks

*An article on this subject, by Dr. Thomson, was published in the "Monthly" for February, 1885, and, as a continuation of that paper, we give herewith from the "Medical News" an account of the more recent experience of the Pennsylvania Railroad with the system of examinations mentioned, and the results of its application to other lines.—Ed.

submitted to me, and the color-blind men sent to my office for final action. Mr. Pugh, General Manager, stated, in September, 1884, that there were thus detected four per cent of men color-blind, and ten per cent of men deficient in acuteness of vision, and that, although it was very difficult to keep accurate notes of all examinations, he was satisfied that all dangerous persons had been removed up to that date, when over twelve thousand employés had been submitted to the system.

The statistics obtained upon the two thousand men were used as the standard by all the Division Superintendents, and, however difficult it might be to report to the central office the full details of their examinations, they were always controlled by these known and accepted ratios. It has not been found requisite to send all men deficient to the ophthalmological expert, since they did not demand it, but submitted to the changes rendered necessary without opposition; hence, I am unable to furnish exact reports of the examinations made at remote portions of the road. Most of the color-blind men have passed under my hands, as well as many cases of astigmatism, optical defects, and diseases or injuries reducing the sight below the standard, and the results may some time be found worthy of publication.

An opportunity to present the last opinions of the officers of the Pennsylvania Railroad has been afforded by a request which was made by the German Government, through its Minister, to the Surgeon-General of the United States Army, for statistical and other information on the subject, and this letter, referred to me by the Surgeon-General, has been answered by Mr. Pugh, who has kindly made efforts to obtain the figures from the great organization of which he is General Manager. He writes, under date of July 7, 1887, and says:

"I regret that so long a time has elapsed since the receipt of yours of May 25th, and this reply. The delay has been occasioned by our efforts to obtain some statistical information, which I regret to find has not been kept up as closely as was intended. I inclose herewith statements showing the number of employés examined during the past five years, with the results stated.

"I can only add that we have attained the most satisfactory results from the system, and I think we can confidently claim that sense of security which follows the belief that we have no one employed in any position in which the use of signals is required, whose color-sense and sense of vision will not enable him to accurately determine all signals by which his action is governed."

Total number examined on lines east of Erie	25,158
Color-blind	481
Defective vision	661
Hearing	158

I am informed that the system has been found so satisfactory that it has been extended to the lines west of Pittsburg, and no doubt is now in use throughout all the lines controlled by the Pennsylvania

Railroad, including seven thousand miles of track and one hundred thousand employés.

It will be remembered that this system is also used to prevent the admission of defective men into the service, and that the apparently small percentage of color-blind in this table may be ascribed to the non-application of men who know their deficiency, and to the fact that men in the service knowing their defect would leave the road before examination, and thus escape detection, and be enabled to gain employment on other roads where no examinations are required. Perhaps twelve or thirteen thousand was the number who were subject to examination by virtue of being in positions where color-signals were used to direct them, in 1884, and the difference between that number and the total twenty-five thousand would be made up of new men who would present a small ratio of those below the standard, since men conscious of color-blindness, or poor sight, would not apply.

The fact that the intelligent officers of the Pennsylvania Railroad have adopted this system, purged their old force of all dangerous men, extended its use to all parts of their immense railroad, and now oppose it as a barrier to the admission of men thus unfit for service, is the best evidence that can be adduced to claim for it a successful place among the efforts to render scientific truths of practical value to the world. It is hoped that the Reading Railroad will be sustained in its contest with its employés by the example so quietly conducted by the Pennsylvania Railroad, and that the reform so necessary for the traveling public and for those employés who carry their lives in their hands daily, may be conducted to a happy finish.

THE SAVAGERY OF BOYHOOD.

By JOHN JOHNSON, Jr.

THE following train of reflection was suggested to me by reading, among a number of compositions by my pupils, this blood-curdling narrative:

"Not long ago, when one of the boys went up to bed, he was standing close to the window, undressing himself, and a little bird came fluttering around the window on the outside. At first we thought it was a bat, but after a while we came to the conclusion that it was a little bird. Then we opened the window and let it in. It seemed to be crippled or very cold, and it could not fly very well, although it would keep out of our reach. We tried to catch it by running after it, but we soon got tired of that, and we began to throw our hats at it. Sometimes we would strike it with a hat, but that didn't do much good, until the bird was tired of flying, and it got under a bed, and we caught it. Then we went up the hall, and wrung its head off.

After we had wrung its head off, we got the wings, and threw the rest of the bird out of the window. J. F. T."

My twelve-year-old Procrustes has brought out his deed in all its stark brutality, and evidently he is not ashamed of it. His language, so entirely devoid of all compunction, is sufficient evidence on this point; but I can strengthen the testimony by my experience that a boy never puts into his composition any idea the propriety of which he questions in the least. As every one knows who has many dealings with children, they are remarkably shy about letting their feelings be known to grown people, and they will scarcely ever deliberately express a thought before their elders which they think may be disapproved of. Consequently, I feel very sure that the young savage just quoted saw nothing evil in his act, and that his unawakened conscience gave him no pang as he recalled the heartless butchery of the bewildered guest against whom he had violated the laws of hospitality. On the contrary, there is a tone about his words as of savage complacency—the complacency of the Dyak who recounts his successes in the head-hunt, and gloats over his barbarities as they rise bloody before his mind's eye.

Ruthless as Procrustes appears to be, it is highly probable that his barbarous state of mind is not in any great degree exceptional, but may rather be taken as a fair example of the mental and moral condition of most of the healthy boys of his time of life now growing up in this country. At first sight, this may seem far too disparaging an opinion of the moral nature of boys; and unquestionably it is a lower view than that reflected in the juvenile magazines and Sunday-school books. Yet some consideration, I think, will show that it is nearly correct.

Almost every father whose family contains two or three healthy boys under the age of fifteen, certainly every teacher in a boys' school, unless he altogether fails to reach the hearts of the youngsters around him, must feel, after reading a volume or two of current children's literature, that his own boys lack the tender sympathy, the overflowing compassion, which it is now the fashion to impute to the heroes of juvenile fiction. Those persons who are not in a position to come in contact with the children of to-day need only to recall to memory the scenes of their own childhood in order to find repeated episodes in which a suffering kitten or puppy was the central and unpitied figure. The callousness of the children of one's own circle will be made evident after a few minutes spent in such clarifying (though, to sensitive people, rather annoying) introspection; and what is true of one circle in this regard is approximately true of all. My own conviction is, that healthy boys under fifteen feel very little compassion for any suffering but that of their near relatives, their close friends, and occasionally their pet animals. Not only do they evince little compassion,

but they often show more than an entire apathy, even an actual pleasure, at the sight of pain inflicted upon animals; and some, with whom we need not now concern ourselves, take a delight that to grown people seems almost fiendish in tormenting their weaker playfellows.

Of course, there are to be found instances, as rare as they are delightful, of highly sympathetic children; but such are to be discriminated from the ordinary run of boys. The children who habitually show this spirit are to be reckoned as moral prodigies, far above the common level; and they are no more to be compared in point of morality with ordinary healthy boys than in point of intellectual power John Stuart Mill, reading Lucan and Plato in his eighth year, is to be compared with the primary pupils struggling through the mysteries of "carrying" and "borrowing." Boys of fourteen who share our feeling of pain at the useless shooting of a bluebird, who have no instinctive impulse to maim a ground-squirrel by a well-aimed shot from a sling, are examples of moral precocity. Like intellectual precocity, this may be very enjoyable to the family in which it occurs; but the probability is, that it is the accompaniment of some unhealthy state, which may be entirely unobserved by the child's admiring but undiscriminating friends. On the subject of intellectual precocity, thanks to the able and tireless efforts of the apostles of the "new education," many people now have sound notions, and the more sensible mothers and fathers among us no longer desire to model their boys after the pattern of the young Macaulay or Pascal. Indeed, not a few of them have come to so enlightened a state that they actually feel some wholesome alarm lest their "intellectual early risers," as Professor Huxley has wittily said, should "be conceited all the forenoon of life and stupid all the afternoon." But, while the judicious have thus become satisfied to see a child's mental powers rise slowly and healthily from the first faint glimmer of intelligence to whatever degree of vigor and brilliancy his endowment may enable them to reach, yet very many people whom we can not class among the Bœotians, and who count most of the authors of children's literature among their number, seem confidently to expect a boy's moral nature, long before his legs have outgrown his knickerbockers, to burst forth with almost the fervor of Mr. Bergh's ebullient conscience. Doubtless they are inexpressibly shocked when they learn, as in the course of things they soon must, that the humane inpulse is as soundly dormant in the breast of their ten-year-old offspring as in the bosom of a Fuegian or a Guacho.

But, when all the circumstances are considered, it will perhaps appear that moral precocity is no more to be desired than intellectual precocity, because the existence of either indicates that the development of the child in which it appears is abnormal. An early appearance of the sympathies depends upon an early development of mental functions, which properly are dormant until later in life; and pre-

cocious emotion is an unnatural state, produced by an unnatural and therefore unhealthy development of the brain. Consider for a moment what the seat of the emotions—the brain—is. Like all the other organs of the body, the brain grows from a few simple cells, and reaches its fullness and complexity as the organ of mind after passing through numerous simpler conditions. Like the other portions of the wonderful machine in which each of us lives, moves, and has being, the brain is subject to the all-embracing law of animal existence, which declares the development of the individual to be an epitome of the development of his race. By way of illustration, it is well to note the well-established and now familiar fact that man in his prenatal life goes through several stages, in which he may be successively described as a moner, an ascidian, a fish, a reptile, and a mammal. The entire series of forms through which he passes is so varied that a description of his embryonic existence is almost an epitome of the animal kingdom. And after the appearance in the world of the infant poet or sculptor, he bears in his countenance the marks of his descent from savage ancestors, whose low and ugly forehead, flat nose, and cavernous nostrils are reproduced in his infantile lineaments.

The brain, being merely one of the bodily organs, shares in the growth of the whole organism, and must consequently be weak and undeveloped in its early stages. It becomes stronger only by slow degrees, and in the healthy child it is, as we should expect when we consider his ancestry, the mind of a savage. The civilized child, like the adult savage, has no abstract ideas, and his words number only a few hundreds. One of the writers quoted by Lubbock, in speaking of the intellects of savages, says, "A short conversation wearies them, particularly if questions are asked that require efforts of thought or memory." Such a description, as every teacher knows, is most applicable to our own children, and illustrates how closely their mental state approaches that of the savage. An extremely close observer, Mr. Francis Galton, in reference to some of the lower tribes of Africans, makes the striking remark that "the motives of an adult barbarian are very similar to those of a civilized child."

These facts being granted, it is most instructive to notice how our every-day experience of children's ways points to analogies to the emotions of savages. How complete and how savage is that disregard for filth against which the careful housewife has daily to struggle to accomplish the "shining morning face" she sends away to school! With what a barbarous gluttony does the boy gorge himself with cake, like the Eskimo who forced his wife to stuff him with blubber until he fell down unconscious!

Turn now from these unpleasant traits to that of cruelty, with which we began this discussion. Cruelty seems to be a fundamental fact in the nature of children; but, when we recall the course and the law of man's development, we find nothing depressing in the existence of this savage

quality in our boys. As one of the inevitable accompaniments of the savage state, we should expect to find heartlessness among children. "There can be no doubt," says Sir John Lubbock, perhaps the highest authority on the subject of the qualities of barbarians—"there can be no doubt that, as an almost universal rule, savages are cruel." Their moral code permits, if it does not inculcate, revenge and murder; and no stigma whatever is attached to a deed so unnatural to our eyes as maternal infanticide. The stories of inhumanity with which modern travelers fill their volumes, if true of the savages of to-day, will serve to characterize the savages of the past; and there is no fact better established than that the savages of times gone by numbered among themselves our own ancestors. During countless thousands of years, from the unknown date when the Miocene drifts covered the valleys of Western Europe, and buried the war-axes of the inhabitants who hunted beasts and men through the forest, to a time which, in comparison with that date, is as near as yesterday, the ancestors of the present civilized races roamed about as hungry, ill-clad savages. Their daily need of food was supplied by means of the suffering they inflicted upon cave-bears and musk-oxen, and sometimes they slew and ate their fellow-men, and cleft their bones for marrow. The shedding of blood, as the almost inseparable accompaniment of the satisfaction of the most imperious of all desires, hunger, must have become, according to the well-known principle of the association of ideas, in itself a pleasure. Like the savages of to-day, those fierce progenitors of ours must have delighted in the torture of captured enemies. Thus, during long ages, compassion was unknown, and it appears to have been lately acquired by the now dominant races. Indeed, even among so highly cultivated a people as the Romans, it remained almost unknown until comparatively recent times—say fifteen hundred years ago—in proof of which may be noted their heartless fondness for the bloody sports of the arena.

The emotion of pity, then, appeared late in the history of the race; and, in view of the law of our development, which carries us along the path our ancestors have trod, how can we expect our boys to be anything else but cruel? How far is it judicious to go, in trying to alter the natural course of a child's mental growth by imposing upon him ideas which in due course he will not share until later? This last question is inviting, but we will not go into its solution at present, contenting ourselves with observing that because a boy shows no compunction at giving pain to a captive bird, or calmly lacerates the feelings of a family of squirrels, merely to give himself a few soon-neglected pets, is no reason for expecting him to grow up a monster of cruelty. And we will further venture to suggest that much of the immorality of boys is a necessary consequence of their descent, as a corollary of which follows the aphorism of my witty friend, "A good boy is diseased."

FETICH-FAITH IN WESTERN AFRICA.

By H. NIPPERDEY.

WHILE I was living, in 1884, on the shore of the Kuilu-Niadi River, a fetich-tree was shown me during a walk on the left bank of the stream. It was a *Hyphæne*-palm, the trunk of which was bent down from a height of about sixteen feet till it touched the ground. It had also grown in a circle around another tree of the same species that stood straight in such a way as to form a crown around it at a height of about ten feet. Within the circle inclosed by the tree-stem lay an old, weathered elephant-tusk. I thought at first that I would send a report of this curious phenomenon to Europe, but afterward concluded to make a more thorough study of fetiches and the belief in them, and obtain a little clearer light on the subject. I was greatly assisted in my efforts by Hübbe-Schleiden's excellent work on "Ethiopia," which I made my guide in my researches. I propose to communicate in this paper what I have learned concerning the fetiches of West Africa.

The word *fetich* is derived from the Portuguese, in which *feitigo* means a witch. The use of the word is confined to the coast, and its meaning is unknown to the negroes of the interior. Various expressions are in use on the lower Congo—for example, M'kissi for fetich; N'gille-N'gille for the means by which magic power is given to the fetich; M'lungo is a doctor; and N'doshi are beings of a character similar to that of the were-wolves of European popular mythology. It is much harder to explain the nature of the fetich, for the negro himself is not clear on that subject. I therefore fall back on my authorities, Hübbe-Schleiden and Max Müller. The former says that fetichism is not a proper designation for a religion, for Judaism and Christianity have their fetiches as well as the Nature-religions; the word should be used as analogous with a word-symbol or emblem, as Max Müller has shown. If we should say that the cross is the fetich of Christianity, some persons would think we were guilty of blasphemy, but they would be only those who have no real conception of what a fetich is. The phrase is really as far from blasphemy as science is from idle chattering. The confusion of the emblem with the thought represented, of the material with the spiritual, of the visible with the invisible, is not religion, but superstition, whether it be the worship of fetiches or of relics, idolatry or the adoration of saints. Max Müller says: "We may fancy ourselves secure against the fetich-worship of the poor negro, but there are few if any among us who have not their fetich or idol, either in their church or their heart. The negro's religion is not belief in the power of the fetich, but belief in the power of the spirit through which the fetich is of effect."

One important thought in particular is not peculiar to fetich-faith, but is mixed with the religions of most people; but the negro suffers more than any other man from the fear of ghosts. "In the foaming water, in the dazzling lightning, in the murmuring wind, he sees the working of self-existing spiritual beings. And why should we deprive an anxious human heart of the comforting faith that a piece of hide or a dried snake-head carefully wrapped up and worn about the body can protect him?"

Every Congo negro carries a M'kissi upon himself; and there may be thousands of kinds of them that escape the eyes of the white man. The N'ganga, or medicine-man, is usually the fabricant of the fetich, and whatever he finds good to impose upon his simple-minded, credulous brethren for a high price, sewed up in cloth or leather or inclosed in a goat's horn, is doubly valuable in the eyes of its new possessor, because he believes that his M'kissi stands in a personal relation to himself; and he can not be induced to give it up to a white man for any price.—Among these amulets are dried snakes and lizards' heads, little pieces of skin, feathers of certain birds, and parts of known poison-plants. The eye-teeth of leopards are an exceedingly valuable fetich on the Kroo coast, and it is easy to buy with them articles of vastly more real value, like ivory rings, etc. The Kabinda negroes wear a little brown shell, very much like our *Linnæus*, on their necks. The shells are sealed with wax, and are made, perhaps, vessels containing magic medicines. The large snail-shells found in the Cassava or Manioc fields on the Kuilu Niadi are also M'kissi, and are set in the fields by the women who till them to protect their plantations. One of the chiefs in the upper Kuilu Niadi, in N'kuangila, has a M'kissi against the tornado: it is an antelope-horn. On the approach of a storm the king calls his people together; the horn is stuck in the ground, and a dance is begun around it, which is kept up, in spite of wind and rain, till the tornado is over. Every house in the village has its M'kissi; they are frequently put over the door or brought inside, and then they protect the house from fire and robbery. These penates of the negroes are sometimes figures very artistically cut in wood or ivory, and show a certain degree of native skill and taste in the people. But it is not the guardians of his house only that the negro thus represents in material figures; he also gives corporeal form to diseases, like small-pox, syphilis, and fever. Every town has its war-fetich; and the principle of creation is represented in male and female M'kissi. The *Hyphæne* palm-tree on the Kuilu shows how the negro sees a spirit at work in the wonders of Nature which he can not explain. That tree was M'kissi to the whole village. Good medicines with which the negroes are acquainted, or of which they experience the salutary effects, are also called M'kissi. A negro called a dose of castor-oil which I gave him, *M'kissi mbote*, or good medicine.

The white man—*mondela* or *mundele*—is regarded by tribes which

have seen only a few of the white race, as a fetich, and is feared by them, especially by their women and children, as if he were a ghost. On a journey between Isangile and Manzanger I saw a negro who had covered his whole body with white colors. He was a senator of that secret society of which the N'ganga is chief. These people speak their own secret language, and exercise to a certain extent over the other negroes the office of policemen. Every negro has to turn away from them, because it is believed that the women and children, at least, who look upon one will die. In Wunde I saw in the fetich-house the life-size photograph of a white woman sewed upon a red cloth. It was, as I afterward learned, a part of the effects of a servant of the association who had died on the Congo. I especially remarked, while I was living on the Congo, that photographs are among the things which the negroes most readily steal, and that they take them whenever they can get their hands upon them.

A few words, now, on the fetich-doctor or medicine-man, the N'ganga of the negro, who is also his priest, physician, and chief-justice. If any one in the village dies, the negroes, who can not comprehend that any one should die a natural death, believe that he must have been killed by enchantment or by the evil influence of some other person; in short, that another person was the cause of his death. It is the N'ganga's business to find out who this person is. He consults with the spirits by moonlight, and communicates the result of his interview to the people. The accused person is then subjected to the trial by *cassa*. Cassa is the bark of a large tree, the *Erythrophlæum Guineense* (*Leguminosæ Cæsalpinceæ*), and contains a very strong poison. The delinquent is forced to drink a solution of this bark, which has been prepared by the N'ganga. If he vomits the draught up immediately, he is innocent; but, if it remains in his stomach, he must die. In this case the negroes never wait for the operation of the poison, but fall upon him with sticks and stones, or drive the life out of him in some still more savage way. The issue of the trial by cassa of course lies with the N'ganga, and, if the delinquent can pay enough, that functionary will probably save his life. At one time, the king of a village on the upper Kuilu was very sick. The N'ganga quietly ordered a grand dance, with immense noise, to drive away the evil spirits of the royal sickness. The whites, who had a station in the vicinity, could not sleep at night for the din, and therefore, calling up the N'ganga, offered him several pieces of cloth if he would stop the dance. The N'ganga took the cloth, and there was no more dancing. Such is the N'ganga, the great medicine-man of the negroes. If any one asks whether the missions, of which there are now several on the Congo, can not exert an influence on the fetich-faith of the negroes, I would answer that an influence is possible, but only, I believe, by substituting for the present fetiches other Christian objects such as I saw in the French mission at Laudana, where the converted youth

wore little figures of saints on their necks. It will be very hard to take the fetich-faith entirely away from the negroes. It is too deeply lodged in their natures.—*Translated for the Popular Science Monthly from Das Ausland.*

WHAT AMERICAN ZOÖLOGISTS HAVE DONE FOR EVOLUTION.*

By Professor EDWARD S. MORSE.

ELEVEN years ago I had the honor of reading before this Association an address in which an attempt was made to show what American zoölogists had done for evolution. (See "Popular Science Monthly," Vol. X, pages 1 and 181.) My reasons for selecting this subject were, first, that no general review of this nature had been made; and, second, that many of the oft-repeated examples in support of the derivative theory were from European sources and did not carry the weight of equally important facts, the records of which were concealed in our own scientific journals. Darwin was pleased to write to me that most of the facts I had mentioned were familiar to him; but, to use his own words, he was amazed at their number and importance when brought together in this manner. The encouragement of his recognition has led me to select a continuation of this theme as a subject for the customary presidential address, a task which is at best a thankless if not a profitless one. Had I faintly realized, however, the increasing number and importance of the contributions made by our students on this subject, I should certainly have chosen a different theme.

Incomplete as is this record of ten years' work, I am compelled to present it. In the Buffalo address two marked periods in the work of the zoölogists in this country are recognized: the one period embracing the work of the topographers, the field-surveyors in the science; the other period dating from the advent of Agassiz, with the wonderful impulse he imparted to the study by his enthusiasm and devotion. A third period in American zoölogical science, and by far the most important awakening, dates from the publication of Darwin's "Origin of Species." Its effect on zoölogical literature was striking. The papers were first tinged with the new doctrine, then saturated, and now, without reference to the theory, derivation is taken for granted.

As zoölogists we are indebted to Darwin for the wide-spread public interest in our work. Before Darwin the importance of our special studies was far outweighed by the practical value placed upon science, in the application of which an immediate material gain was assured. Chemistry, physics, geology were important to the public only because

* Address of the retiring President of the American Association for the Advancement of Science, delivered at the New York meeting, August 10, 1887.

a practical application of these sciences was capable of showing an immediate material return.

Agassiz, in his appeal to the State for appropriations for the great museum at Cambridge, insisted that there were higher dividends than those of money to be looked for in endowments for zoölogical museums, and these were intellectual dividends. While the force of this appeal will always remain true, the transcendent importance of the naturalist's studies from the standpoint of Darwin is widely recognized. Man now becomes an object of rigid scientific scrutiny from the new position which has shed such a flood of light upon the animals below him. His habits, behavior, the physical influences of his environment and their effects upon him, transmission of peculiarities through the laws of heredity—all these factors are directly implicated in the burning questions and problems which agitate him to-day. Questions of labor, temperance, prison reform, distribution of charities, religious agitations, are questions immediately concerning the mammal man, and are now to be seriously studied from the solid standpoint of observation and experiment and not from the emotional and often incongruous attitude of the Church. To a naturalist it may seem well-nigh profitless to discuss the question of evolution since the battle has been won, and if there be any discussion it is as to the relative merits and force of the various factors involved. The public, however, are greatly interested in the matter, as may be seen by a renewal of the fight in the English reviews, and the agitation is still kept up by well-meaning though ignorant advisers, who insist that Science has not yet accepted the doctrine ; and great Church organizations meet to condemn and expel their teachers of science from certain schools of learning because their teachings are imbued with the heresy.

Dr. Asa Gray,* in his discriminating biographical memoir of Darwin, says, in regard to the "Doctrine of Descent" : "It is an advance from which it is evidently impossible to recede. As has been said of the theory of the Conservation of Energy, so of this : 'The proof of this great generalization, like that of all other generalizations, lies mainly in the fact that the evidence in its favor is continually augmenting, while that against it is continually diminishing, as the progress of science reveals to us more and more the working of the universe.'" Let us examine, then, the evidences, trivial as well as important, that have been recorded by American zoölogists within the past ten years in support of the derivative theory.

Without further apology for the very imperfect character of this survey, let me at once begin by calling attention first to the testimony regarding the variation in habits and evidences of reasoning power in animals. The establishment of individual variation in mental powers, change in habits, etc., lies at the foundation of Darwinism as furnishing material for selective action. There is no

* "Proceedings of the American Academy of Arts and Sciences," vol. xvii, p. 449.

group of animals which exceeds the birds in varied and suggestive material for the evolutionist. It is a significant fact that the birds, which appeared to Cuvier and his contemporaries a closed type, a group that seemed to fulfill the ideal conception of a class archetype, as compared with other groups which had their open as well as obscure relationships, should be of all groups the one that first yielded its exclusive characteristics. In fact, there is no group in which the barriers have been so completely demolished as in this apparently distinct and isolated class. An attentive and patient study of the birds has established almost every point defined by Darwin in his theory of natural selection. One has only to recall the marked reptilian affinities as shown in their embryological and paleontological history. Besides all these structural relationships, the birds possess as a group remarkable and striking illustrations of variation in color, size, marking, nesting, albinism, molting, migration, song, geographical variation, sexual selection, secondary sexual characters, protective coloring; and in their habits show surprising mechanical cunning and ingenuity, curious and inexplicable freaks, parental affection, hybridity—indeed, the student need go no further than the birds to establish every principle of the derivative theory.

The many observations on the nesting habits of birds would form a curious chapter as illustrating the individual peculiarities of these creatures.

Dr. A. S. Packard* records the fact, as related to him by Mr. Wyatt, of wild geese nesting in large cottonwood-trees on Snake River, west of the Rocky Mountains; and Dr. Coues, in his "Birds of the Northwest," says wild geese "nest in various parts of the Upper Missouri and Yellowstone regions in trees." Mr. H. W. Turner† observes a robin nesting on the ground. The late Dr. T. M. Brewer‡ points out some very curious "variations in the nests of the same species of birds." He not only observes individual variation in nest-structure, but shows that in different regions of the country birds of the same species build different kinds of nests, and in reflecting on these peculiarities he is led to say, "If we can not understand what it can be that stimulates an *Empidonax* in Staten Island to build a pensile nest, while its fellow in Indiana builds one like a deep cup and surrounded with thorns, and another group in Pennsylvania put theirs on an exposed tree-top, and so flat that the eggs seem liable to roll out, we must see that some cause, hidden to us, is gradually effecting changes that sooner or later may become universal in the species, though which it is to be we may not be able to imagine."

Mr. J. A. Allen,# in writing on the inadequate theory of birds' nests, shows grave and important exceptions to Wallace's theory, though he subscribes heartily to his philosophy of birds' nests. He

* "American Naturalist," vol. xii, p. 54. † Ibid., vol. xii, p. 53. ‡ Ibid., vol. xii, p. 35.
# "Bulletin of the Nuttall Ornithological Club," vol. iii, p. 25.

expresses surprise that closely allied species of birds should oftentimes build divers kinds of nests, overlooking the fact that even closely allied varieties of man build entirely unlike houses.

Mr. F. H. Knowlton* records a cliff-swallow appropriating, for the construction of its own nest, pellets of mud which were being brought by another swallow. Also the curious fact that a number of swallows were observed busily engaged in sealing up a nest in which one of their comrades lay dead. Among the curious traits of birds, Mr. H. B. Bailey† communicates some new ones observed in the red-headed woodpecker by Mr. Agersborg, of Dakota Territory. This gentleman had observed one of these birds wedging grasshoppers in a large crack of an old oak-post. Nearly a hundred were stored away in this manner, the bird afterward feeding at leisure on the supply. This parallels the habit of the California woodpecker storing acorns in holes in the tree and subsequently feeding on the fully developed larvæ within the seed.

Mr. O. P. Hay,‡ in a late number of "The Auk," has an interesting paper on the red-headed woodpecker as a hoarder, showing that the bird makes accumulations of beechnuts, pounding them between the shingles of a roof, wedging them into crevices, and storing them in cavities in trees.

The plausible suggestion made by Darwin as to the agency of aquatic birds in the wide dispersal of fresh-water mollusks, was singularly confirmed several years after by Mr. Arthur F. Gray shooting a duck which had clinging to one of its toes a fresh-water mussel. Dr. J. W. Fewkes* has recently recorded the shooting of a duck in Sebec, Maine, which was in like manner transporting a fresh-water mussel. The same bird had been observed several days before with this curious companion clinging to its foot, and had the duck been migrating at the time it might have transported the mussel many hundreds of miles. In this connection it would be an interesting inquiry as to how far the similarity observed in north temperate and circumpolar animals is due to the annual migration of birds north and south.

Mr. William Brewster‖ notes some interesting features in the habits of a young Kittiwake gull of the St. Lawrence. He brought home a young one, its mate having died of thirst, the other one surviving through the accidental discovery that the bird drank only salt-water! Both the birds obstinately refused to drink fresh water. Observations on this bird by Professor A. Hyatt showed how slowly and timidly it acquired the art of swimming and flying. The bird when first forced to fly was thrown into the air, and, to the surprise of Professor Hyatt, flew with great rapidity and precision, circling about the house and through the apple-trees, and, finally, flew near him several times in

* "Bulletin of the Nuttall Ornithological Club," vol. vi, p. 55.
† Ibid., vol. iii, p. 97.
‡ "The Auk," vol. iv, p. 193.
* Ibid., vol. i, p. 195.
‖ "Proceedings of the Boston Society of Natural History," vol. xxii, p. 364.

the greatest agitation till he caught the bird, which was completely exhausted. For a long time the bird went through this manœuvre, showing that while he knew how to fly it could not alight, though it finally acquired this faculty. Professor L. A. Lee* records a remarkable attack made on him by a marsh-hawk, and Mr. Abbott M. Frazer† tells of a tame crow deliberately standing on an ant-hill and permitting the ants to remove the parasites from its feathers. In this connection a paper by Mr. Joseph F. James‡ should be read, in which he shows by a number of arguments that animals not only present a reasoning faculty, but that this faculty has been the result of slow evolution.

Mr. Xenos Clark,* in an exceedingly interesting article on the music of animals, and particularly the music of birds, concludes by saying there is "a theory for the origin of melody, whether human or extra-human, which, besides the usual basis of physiological acoustics, employs the law of modified, inherited, selected, and adapted structure—i. e., the law of evolution."

Mr. Ruthven Deane‖ records cases of albinism and melanism in a great many families of birds; and Mr. N. C. Brown△ shows the variable abundance of birds at the same locality in different years. In this connection it will be of interest to read Dr. L. P. Gratacap's◊ paper entitled "Zoic Maxima, or Periods of Numerical Variations in Animals."

The behavior of wild birds when kept in confinement, and the attempts made in domesticating them, have always furnished an interesting field for study. The curious freaks and impulses which they often betray, the changes they show under the new conditions, indicate in some measure the plasticity of their organization.

Hon. John D. Caton,‡ in an interesting paper on "Unnatural Attachments among Animals," records a curious fondness shown by a crane for a number of pigs; and in another paper on the "Wild Turkey and its Domestication,"‡ this writer has made some valuable records of the successive changes which take place in the bird during this process: changes in color, during which the more conspicuous features of protective coloring are lost; changes in habit, in which is seen the undoing or relaxing of those features which indicate constant vigilance, from carrying itself in a semi-erect attitude, perching on the tallest trees, covering up the eggs carefully with leaves when off the nest, etc., to moving in an horizontal attitude, perching near the ground, covering the eggs but slightly, or carelessly, etc., and losing that wildness which characterizes the bird in its wild state. At the breeding season, however, the females became wild again, but this was a feature too deeply implanted to show modification in the time allotted to Mr.

* "Bulletin of the Nuttall Ornithological Club," vol. v, p. 186. † Ibid., vol. i, p. 76.
‡ "American Naturalist," vol. xv, p. 604. * Ibid., vol. xiii, p. 209.
‖ "Bulletin of the Nuttall Ornithological Club," vol. i, p. 20. △ Ibid., vol. i, p. 15.
◊ "American Naturalist," vol. xx, p. 1009. ‡ Ibid., vol. xvii, p. 359.
‡ Ibid., vol. xi, p. 321.

Caton's experiment. The same writer* has also observed in the Hawaiian Islands the effects of reversion to a wild state of different kinds of domestic animals which have from time to time been carried there. Among other animals he was fortunate enough to observe the undoing stages in the domestic turkey and the assumption of those features which characterize the wild bird.

A great many facts illustrating the plainest features of natural selection, protective coloring, mimicry, etc., have been recorded in our journals from time to time. A brief allusion may be made to a few of these.

Professor Samuel F. Clarke† notices a pronounced case of natural selection, a case which must often occur in nature. He kept in large glass jars masses of eggs of Amblystoma. As soon as these eggs began to hatch he found it difficult to provide the young with suitable food, and yet they seemed to thrive. On examination, many of them were seen to be engaged in nibbling the branchia of others, and as they increased in size they were seen to swallow the weaker individuals bodily and hence grow with increased rapidity. "Here, then," he says, "was a very interesting case of natural selection by survival of the fittest, all the weaker individuals being destroyed and actually aiding the stronger ones by serving them as food until they could pass through their changes and escape to other regions where food was more abundant." Professor B. G. Wilder has recorded a similar condition of things in a species of spider where the young spiders within the case inclosing the eggs were feeding on the weaker ones. Professor Henry L. Osborn‡ observes a curious case of mimicry at Beaufort in the coloring of a species of Ovulum which frequents a species of Leptogorgia. The Ovulum was yellow in color on the yellow variety of this sea-fan, and purple when living on the purple variety. Dr. R. E. C. Stearns# has made some interesting notes on protective coloring in *Phrynosomæ*. Having collected these horned lizards (or toads as they are commonly called) in Central California, he has noticed that if the ground region they frequent is yellowish, the lizards are without exception of that color; if ashen-gray, then that color is simulated, and this without exception. Further than this he is "led to believe that a sufficient number of living specimens will show a similar protective factor in degree of development of the scale imbrications, tubercles, so called, and horns—or, in brief, in the sculpture aspect as related to the surface texture of the ground which forms the local habitat of these forms." Dr. A. S. Packard‖ has observed the partiality of white butterflies for white flowers. He notices the European cabbage-butterfly, which is white, go directly to the white aster and rarely visit the golden-rod; while the yellow sulphur butterfly vis-

* "American Naturalist," vol. xv, p. 955.

† Ibid., vol. xii, p. 615.

‡ "Science," vol. vi, p. 9.

"American Naturalist," vol. xvii, p. 1077.

‖ Ibid., vol. xi, p. 243.

its the yellow flowers of the golden-rod oftener than those of the aster. The same author* also observed a harmless Egerian moth which deceived the sharp eye of a trained entomologist by its resemblance to a wasp, and asks why a bird may not be equally deceived. Miss Sarah P. Monks† observed a case of mimetic coloring in tadpoles, their tails precisely resembling the leaves of an aquatic plant, Ludovidgia.

Miss Mary E. Murtfeldt‡ having noticed that the butterfly, *Pyrameis Hunteri*, always deposited its eggs on the plant Antennaria, she was surprised to find a number of larvæ of this butterfly on Artemisia. The customary plant being rare in the immediate vicinity, the butterfly had been misled by the surface resemblance of the white, cottony leaves of the Artemisia to those of the accustomed food-plant. In this case the larvæ all died.

An unquestionable fact has been finally established by recent methods of observation on the habits of insects and other animals, and that is that individuals of the same species vary in intelligence; that they are not automata; that they are not impelled by a blind instinct to perform certain acts with unerring accuracy, but, on the contrary, that they vary and often greatly vary in their ability to provide for their young, in their skill to secure sufficient food, in their wit to avoid danger—in other words, they make blunders and mistakes and involve their progeny and even their colony in ruin. This individual variation in intelligence is brought out very clearly by a patient series of observations made by Drs. G. W. and E. G. Peckham# on the special senses of wasps. They not only repeated many of the experiments of Sir John Lubbock, but many new and ingenious experiments were devised. Their studies were for the purpose of investigating the mental power, sense of hearing, color, direction, memory, emotion, power of communication, general intelligence, etc. An interesting result of their painstaking work was the determination of individual differences as to the faculty of memory and power of distinguishing color and direction. This kind of study of the habits of insects has brought to light features of the most surprising character. The remarkable studies of Sir John Lubbock, Dr. Moggridge, and others in Europe, have been paralleled in this country not only by the observations above quoted, but notably by the labors of Rev. H. C. McCook‖ in his studies of the American ants and spiders. In various papers published in the "Proceedings of the Philadelphia Academy of Natural Sciences" and in the "American Naturalist," he has shown many extraordinary and curious features in the life-histories of these animals. The great variety and extent of his work must be my excuse for not referring to it in detail.

Professor G. F. Atkinson,△ in studying a new species of trap-door

* "American Naturalist," vol. xiv, p. 600.
† Ibid., vol. xii, p. 695.
‡ Ibid., vol. xvii, p. 196.
# Historical Society of Wisconsin.
‖ "American Naturalist," vol. xii, p. 431.
△ Ibid., vol. xx, p. 588.

spider, confirms the observations of others as to the creature deliberately attaching fragments of moss to the lid of its nest in order to conceal its position. Dr. Thomas Meehan* describes a hornet that was gifted with great intelligence. He saw this insect struggling with a large locust in unsuccessful attempts to fly away with it. After several fruitless efforts to fly up from the ground with his victim, he finally dragged it fully thirty feet to a tree, to the top of which he laboriously ascended, still clinging to his burden, and having attained this elevated position he flew off in a horizontal direction with the locust. Dr. Meehan truly says, "There was more than instinct in this act, there was reasoning on certain facts and judgment accordingly, and the insect's judgment had proved correct."

A curious case of circumspection in ants is recorded by Dr. Joseph Leidy.† In an empty house he observed some ants feeding on crumbs of bread left by the workman. He at once placed pieces of bread in the different rooms in the house only to find them the next day covered with ants, which he destroyed by causing them to fall into a dish of turpentine. After a few days the ants no longer visited the bread, and he supposed they had been exterminated. A few days after, however, he observed a number of ants in the attic feeding on the body of a dead fly. He immediately got a lot of grasshoppers and distributed their bodies in all the rooms, only to find that they were soon covered with ants, which he destroyed as before. This treat continued attractive for a few days only, when the ants abandoned the food. In brief, he tried meat, cake, and various other articles in turn; the ants for a while frequenting these snares, only to learn the danger involved, and finally avoided them.

The gradual dispersion of species in recent times is of great interest, and careful records should be made of the facts as observed and a collection of large numbers of individuals made, in order to compare them with specimens of the same species in future years, to ascertain the variation which may have taken place and the tendency of that variation. A number of observatians have been published within the last ten years, showing new areas of distribution. *Littorina litorea*, which has been creeping along the coast since 1869, as recorded by Gray, Verrill, and others, has now reached the southern side of Long Island Sound, as observed by Mr. Henry Prime.‡ *Lioplax subcarinata*, an Ohio River species, has been found in the Hudson River at Catskill Landing. *Limax maximus*, first found at Newport, Rhode Island, by Mr. Powel, has since been found at Cambridge, Massachusetts, by Professor Hyatt. *Bythinia tentaculata*, first recorded from Oswego, New York, by Rev. W. M. Beauchamp,* is reported as having been found at Burlington, Vermont, by G. H. Hudson. In the Mohawk

* "Proceedings of the Philadelphia Academy of Natural Sciences," 1878, p. 15.

† "American Journal of Science and Arts," vol. xv, p. 320.

‡ "American Naturalist," vol. xvi, p. 737. * Ibid., vol. xiv, p. 523.

River is a thriving community of this species, the first having been placed there by Dr. James Lewis.

Dr. R. E. C. Stearns,* in commenting on the occurrence of *Mya arenaria* in San Francisco Bay, states that the first record of the species in California was made by Dr. Newcomb in 1874. Within a few years it has increased in great numbers, furnishing a new food-supply for the people. The evidence that it is a recent introduction is seen in the fact that so large and conspicuous a species could not have escaped the eye of the collector. No trace of it has ever been found in the numerous shell-heaps of California, though it is found on the Asiatic coast, from Kamtchatka to the southernmost limits of Japan. Dr. Stearns believes it to have been imported with the oyster transplanted from the Atlantic coast. From large numbers of the shells that I measured, the low index would show that it came from some southern point on the Atlantic coast.

The delicate balance of conditions between organisms, whether it be between individuals of the same species or between widely-separated groups, is an important feature in the question of survival. Professor S. A. Forbes,† in a thoughtful study of certain species of entomostraca in Lake Michigan and the surrounding waters, calls attention to the important part played by these minute crustaceans, showing how they furnished almost the entire food for young fishes, larger crustaceans and even insect larvæ. He writes: "Mollusca, one would say, could afford to be indifferent to them, since they neither eat them nor are eaten by them, nor seem to come in contact with them anywhere, through any of their habits or necessities. But for this very reason these two classes afford an excellent illustration of the stringent system of reactions by which an assemblage of even the most diverse and seemingly independent organisms is held together. . . . If there were no entomostraca for young fishes to eat, there would be very few fishes indeed to feed upon mollusca, and that class would flourish almost without restraint; while, on the other hand, if there were no mollusca for the support of adult fishes, entomostraca would be relieved from a considerable part of the drain upon their numbers, and would multiply accordingly." He is much struck with the fact that in the larger bodies of water, the species of entomostraca show an inferior development in numbers, size, and robustness, and in reproductive power. Their smaller number and size are doubtless due to the relative scarcity of food. "The difference of reproductive energy, as shown by the much smaller egg-masses borne by the lacustrine species, depends upon the vastly greater destruction to which the paludinal crustacea are subjected. Many of the latter occupy waters liable to be exhausted by drought, with a consequent enormous waste of entomostracan life. The opportunity for reproduction is here greatly limited—in some situations to early spring alone—and the

* "American Naturalist," vol. xv, p. 362. † Ibid., vol. xvi, p. 537.

chances for destruction of the summer eggs in the dry and often dusty soil are so numerous that only the most prolific species can maintain themselves under such conditions.

"Further, the marshes and shallower lakes are the favorite breeding-grounds of fishes, which migrate to them in spawning-time, if possible, and it is from the entomostraca found here that most young fishes get their earliest food-supplies—a danger from which the deep-water species are measurably free. Not only is a high reproductive power therefore rendered unnecessary among the latter by their freedom from many dangers to which the shallow-water species are exposed, but in view of the relatively small amount of food available for them, a high rate of multiplication would be a positive injury, and could result only in wholesale starvation."

The effect of birds on insect-life has engaged the attention of the same author.* His inquiry was to ascertain whether birds originated any oscillations in the numerical proportion of insects upon which they feed. Many interesting facts are given which space forbids quoting.

A number of contributions have been made on the influence of environment and on geographical variation, to some of which reference must be made. Professor Alpheus Hyatt† bears unequivocal testimony to the derivative theory, and recognizes clearly the influence of external surroundings in a memoir on the cephalopods, when in stating the law of organic equivalence he says: "The action of physical changes takes effect upon the irritable organism, which necessarily responds to external stimulants by an internal reaction or effort. This action from within upon the parts of the organism modifies their hereditary forms by the production of new growths or changes which are, therefore, adapted to the conditions of the habitat or the physical agents and forces from which they directly or indirectly originate"; or, slightly changing this interpretation in accordance with the same facts, each individual is more or less susceptible to the action of physical influences and those which respond most quickly to these influences, come more promptly in harmony with their environment, which is natural selection pure and simple.

Mr. Charles Morris,‡ in a series of papers on "Organic Physics" and the "Polar Organization of Animals," presents many new and suggestive thoughts on the physico-chemical action in life and development. He concludes that "there are inherent in the germ energies and tendencies, chemical, molecular, or whatever we choose to call them, adapted to the complete unfoldment of the typical form. But, as appears evident, their operation can be checked by influences from external nature. There is a struggle between these contact influences and the innate organic tendencies."

* "American Naturalist," vol. xvii, p. 671.

† "Proceedings of the American Associated Antiquarian Society," vol. xxxii, p. 323.

‡ "American Naturalist," vol. xvii, p. 486.

[*To be continued.*]

THE LANGUAGE OF THE EMOTIONS.

By M. ALFRED FOUILLÉE.

WITH the words "Every gesture is a metaphor," Diderot exactly characterized that translation of the feelings into corresponding movements which we call their expression. But, though the natural language of the physiognomy and of gestures is metaphorical, it need not be inferred that it is composed of symbols in any degree arbitrary. It is rather by a necessary determinism that a particular internal phenomenon is translated by a peculiar external manifestation. Expression is no longer considered a sign that may be detached from the expressed fact; it is an integral part of the fact, or of its history. A man, realizing that his life is in extreme peril and anxious to save it, might, perhaps, be able to preserve his calm; but, as Darwin says, he suffers a tension of his will against his emotion, and the conflict within him is faithfully expressed in the body by the parallel tension of the muscles and the correlative tension of the pulse. Feelings too weak to produce a visible outward expression are marked in the interior of the organs. We should not, then, as the old psychologists did, place the psychological changes and the physiological movements in which they are realized, or prolonged, or expressed, in different worlds.

Darwin attempted a biological explanation of this reciprocally determined connection of the internal feelings with external movements, as arising in the gradual evolution of organisms struggling for existence. Mosso * and Warner † showed that there are physiological and mechanical limitations to the influence of selection and the medium, or that there are internal necessities independent of exterior utility, and assumed that the explanation of the phenomena belongs to physiology. But should not philosophy, we ask, maintain a view yet more of the interior, strictly psychological and sociological? Should it not explain, by the laws of individual or collective consciousness, those facts of expression which are the precise continuation of the mental in the physical and of the physical in the mental? All expression of feeling has, by its definition, a psychological, and, still more, a social, side. There is, in fact, no veritable expression except as there may be a possible interpretation of the movements by other beings forming, with the first one, a society. The language of the passions is eminently communicative. Every living organism is, moreover, itself a society of more elementary organisms, and it is therefore legitimate to inquire if the act of social communication does not begin within the organism itself before extending to other analogous organisms; if there is not a solidarity, at once mechanical and mental, between the parts of the identical organism—

* Angelo Mosso, "La Paura," 1885. † Warner, "Physical Expression," 1886.

brain, heart, and muscles of the face—before the passion is communicated to the other organism. All the acts of expression are, we think, best explained by this physiological and sociological law of solidarity and sympathy.

According to Darwin's theory of explanation, our expressional movements are habits, which, useful at first for the maintenance or defense of life, are preserved and transmitted after they no longer have immediate utility. Most of our gestures are of this class. The signs of affirmation and negation appear to have come from the infant's inclining its head to receive nourishment from its mother's breast, and turning it away when it does not want food. The same gestures, applied to all affirmation and negation, have become hereditary and instinctive with many nations. The acts of clinching the fists and displaying the teeth were primarily voluntary, as preparations for combat and signs of defiance of the enemy; they then became associated with the feeling of anger, then transmitted by heredity, till now we clinch our fist when the enemy is not present, and express the sneer of contempt by an exhibition of the teeth, joined with a backward motion of the head, but with no thought of biting.

However extended the effects of heredity may really be, we have a right to reproach Darwin for having given too great a part to the external causes, to selection and the medium. It is in the very tissues of the organism, in the inmost properties of the living substance, that we should first seek for the mechanical and physiological reasons for the phenomena of expression. Thus, the contraction of the eyebrows in struggle and in pain, which is explained by Darwin as a survival of a movement originally advantageous in combat, is shown by M. Mosso to be a result of the flow of blood to supply the waste of nervous force, and to be physiologically connected with movements of attention and of effort.

In the physiological view, the law that links the emotion with its exterior signs is the same that governs all the manifestations of life and force; it is the law of the equivalence of movements. At any particular moment, the quantity of nervous force corresponding to the state of consciousness called sensation has to expend itself in some way, and engender somewhere an equivalent manifestation of force. The expended force may itself follow three different courses. Sometimes the nervous excitation is transformed simply into cerebral movements corresponding with a mental agitation. This is what takes place, for example, when a child hears a story that interests and moves it. At other times the nervous excitation is transformed into movements of the viscera, and follows the ganglionic nerves. Agreeable thoughts, for example, aid digestion. Fear may paralyze the nerves of the intestine. The heart beats more rapidly under emotion, and sometimes stops, and this influence is accomplished through the means of the pneumogastric nerves. Or the nervous excitation, following the

motor nerves, is transformed into movements of the muscles, which then become the exterior and visible signs of the emotion. A burn on the finger produces a contraction of the features. A lively joy or a deep disquiet throws us into a condition of agitation and purposeless talking and moving about. If the emotion is concentrated, the cerebral disturbance increases in violence as the muscular agitation diminishes. When we spend the excess of our agitation in external movements, in gestures, walking back and forth, tears, and lamentations, the cerebral agitation is correspondingly diminished. These phenomena of diversion are nothing else than particular cases of the conservation of force and the propagation of movements. Sometimes the propagation results in a real metamorphosis. Very violent emotions, producing a reaction on the central parts of the innervation, bring on a sudden paralysis of a number of muscular groups, while feeble disturbances of the sensibility produce superexcitation, which is subsequently replaced by exhaustion. This is what Wundt calls the law of the metamorphosis of nervous action. There result from it effects of balancing and compensation which, in our opinion, are still simply an application of the law of equivalence between movements.

M. Mosso's physiological explanations usually revert into Wundt's law, and with stronger reason into the general law of the equivalence of forces. He has shown that cerebral excitation makes the blood flow to the brain, and that, during intellectual labor, the afflux is sufficient to diminish the volume of the arm. He observed the circulation of the blood in three subjects whose craniums had been partially destroyed. Whenever a stranger came in, or a sudden noise was heard, the cerebral pulse rose immediately. Under the influence of fear the blood flows back to the extremities, to such an extent that a ring can not be pulled off from the finger. M. Mosso has also applied the balance to the study of the circulation. A man is laid full length in a wooden box, arranged as a balance upon a knife-edge, with apparatus for marking the trace of the pulse in the feet and hands, and the changes of volume undergone by these organs. When the balance and the man in it are in equilibrium and repose, something is said to the man. Instantly, by the effect of the excitation received and the attention responding to it, the balance inclines toward the man's head.

Mr. Warner has carefully studied the effects of the emotions in nutrition, which he calls the trophic signs. Maladies that modify nutrition also modify the nervous system, and render it more irritable. The poorly-nourished child often has what the doctors call the nervous—that is, shaky—hand; a more reduced nutrition may end in chorea. Plants also afford examples of excessive irritability, arising from imperfect nutrition. Some sensitive plants were sowed in clear sand, and others in vegetable mold mixed with sand in different proportions. The first, which had nothing but air to feed upon, languished and died; they were extremely sensitive to the lightest touch;

a breath, or a slight motion of the pot made them droop. Those plants which had a third or two thirds of vegetable mold were still irritable, but in a less degree, and would not bloom. Those which had pure vegetable earth became robust and nearly insensitive; striking their leaves with a stick, would make them double up, but they would unfold again almost in an instant.

Besides the general excitation of the cerebral centers, the ganglionic nerves, the circulation, and nutrition, emotion produces a general excitation of the motor nerves and the muscles. According to Mr. Spencer, the excitation of the muscular system should be proportional to the intensity of the feeling, whatever may be its character in other respects; a great joy, like a great grief, should move the whole body. Moreover, Mr. Spencer adds, the force of the passion affects the muscles in the inverse ratio of their size and of the weight of the parts to which they are attached. With the dog and cat, the mobility of the tail makes it capable of furnishing, from its origin, the indication of the rising feeling. The greater or less elevation of the tail is a sign of pleasure; its sidewise beatings, of uneasiness. With man, the muscles of the face are relatively small and very mobile, and for this reason the countenance is the best index of the degree of intensity in feeling; and the ear, motionless in man, is a marked organ of expression in the horse.

The real defect of the theory expounded by Mr. Spencer is, that it is too purely physiological; it has not taken sufficient account of the different effects produced according as the emotions are agreeable or painful. According to his view, the energy of the feeling, whatever may be its nature, is always manifested by an energy of movement. We dance, he says, with joy, as we stamp with rage; we can no more keep still under moral distress than in the exaltation of delight; there are cries of anguish as well as notes of pleasure; and frequently the sounds uttered by children in their sports leave parents in doubt whether vexation or pleasure is their motive. Granted; yet these various manifestations of activity have a resemblance only in the eyes of a distant or superficial spectator. It is hard to suppose that pleasure and pain are primarily manifested by an identical general augmentation of activity.

If the physiologists had considered the emotions in their psychological elements, they would have been better able to account for their manifestations, and would not have involved themselves in an inextricable confusion. In all passion there is first an intellectual element—perception or idea; next a sensible element—pleasure or pain; and, finally, a volitional element—desire or aversion. We must, then, to account completely for an expressive motion, seek first the sensitive and mental state which it expresses; second, the affective state; and, third, the corresponding attitude of the will.

Some psychologists, with Herbart, have looked for the primary ori-

gin of the emotions in the intelligence, and have sought to explain them by a simple play of ideas. Herbart has made the mistake of having seen only the intellectual effect in passion.

M. Wundt rather sees the force of the will under that of the ideas, but he places this force solely in the attention, in what he calls the *apperception*, or the grasp of objects by the intelligence. Emotion is, then, according to him, in its origin, only the effect produced by the feeling on the attention. He concludes that the elementary emotion is surprise, "which behaves, in regard to the more complex movements of the soul, merely as the æsthetic feeling awakened by a simple geometric form as opposed to the effect produced by a work of art." M. Wundt might have added that surprise is the intellectual analogue of the mechanical shock with its well-known elastic effects.

Whatever part of truth this psychological analysis may include, it does not yet seem to us to reach to the real and primordial elements of the emotion. M. Wundt has not asked whether, instead of leading fright up to a sort of surprise, we can not trace surprise back to a sort of fright. In fact, with the inferior animals, astonishment is hardly anything else than fright—that is, aversion. Every novelty not yet looked into is regarded, until further orders, as a danger; animals have not begun to be curious observers of new things, or innovators, but are still conservatives trembling before the unknown. We can not, therefore, consider astonishment the really primitive emotion.

The study of the physical effects will also help to enlighten us as to the nature of the causes. Surprise is manifested by open eyes, elevated eyebrows, open mouth, and raised hands. The eyes are opened to gain a clearer view of the strange object, and the lifting of the eyebrows is an accompaniment to that movement. The opening of the mouth is a consequence of the relaxation of the muscles caused by the flight of nervous force to the brain, and is also a movement promoting the deeper inspiration which is a requisite to energetic effort, and which accompanies the accelerated beatings of the heart. The raising and throwing back of the hands may be regarded as a cautionary movement.

According to the preceding observations, we should seek the real origin of the movements of expression in the effect of the emotions, not on the intelligence, but on the primary activity and the desire. Now, we know that pleasure is essentially an augmentation of vital activity, while pain is a diminution of it; here, therefore, is the principle from which we should start to look for the motions by which pleasures and pains are translated.

The most rudimentary animals, allied to the vegetable kingdom, without nervous and muscular systems, probably did not have the faculty of moving from one point to another in their abode; but there must have existed, even in these primitive species, some tendencies to a superexcitation or a depression of the general activity depending on

the approach or the removal of advantageous or injurious objects. These tendencies, on account of their advantages, are picked out and magnified by natural selection. We may add, with M. Schneider, that the increase of the general activity, even in the absence of a muscular system, is always manifested as expansion, and the decrease of activity as contraction. Expansion and contraction are at the origin of all the other vital movements, and of course of all the signs of expression.

Now let us consider what states of sensibility would correspond among the rudimentary animals with the different modes of general activity, accompanied by movements of expansion and contraction. We shall then have the two following situations: first, approach of an advantageous object, followed by increase of activity beyond the normal state, with pleasure and the movement of general expansion, which is the sign of it; and, second, on the approach of the injurious object, descent of activity below the normal, pain, and the movement of general contraction. With a step further in evolution, the internal movement of contraction, perfecting itself by natural selection, has brought the living being to a massive movement of transport in space, which will take it away from the object—this is the movement of aversion and flight. The movement of expansion, on the contrary, would have provoked a transportation of the whole body of the living being toward the agreeable object—it is the movement of inclination and pursuit. Here are two new signs in the natural language. Add to them the idea of the object that causes the pain or the pleasure, and we shall have conscious repulsion and desire.

These are the primary emotions, with the general movement of the body that expresses them at the first moment. We can say, then, contrary to Mr. Spencer, that, if the intensity of an agreeable feeling is expressed by an exaltation and expansion of motive activity, the intensity of a painful feeling is expressed at once by a contraction and diminution of motive activity. In joy the different organs only reproduce and aid the general movement of expansion; the features dilate, the eyebrows turn upward, the entire physiognomy opens, the voice rises and swells, and the gestures expand in more ample and more numerous movements. We can also say correctly that the lungs dilate, and their play is rendered easier; the cerebral functions are performed with more rapidity and ease; the intelligence is more animated; the sensibility more expansive; the will more kindly. In a word, the expression of joy is a general expression of liberty, and, by that fact, of liberality.

Next, we pass to the immediate expression of pain. At the first moment the depression of activity is manifested by a general depression of the motive force. "The lips are relaxed," says Sir Charles Bell, "the lower jaw drops, the upper eyelid falls and covers half of the pupil, and the eyebrows incline like the mouth." It is true that some other muscles simultaneously become tense, and enter into play,

but Mr. Bain has shown that they are the ones the contraction of which is related to the relaxation of the other muscles. "With a little force a greater one is relaxed." The expenditure in this case is made for saving, and takes place, we think, because the first motion in the face of pain being a movement of conservation and concentration on self, is also a tendency to save the force which is felt to be diminishing—we retire from the pain, and try to recover ourselves. The first stage of pain does not last long, for the reaction begins at once. While the will can consent to pleasure, it can not consent to pain. It defends itself, it struggles, against it. After the first stroke of pain that casts down, we perceive the signs of effort. Sometimes the effort is spasmodic, and involves a prodigality of force that can hardly fail to bring on quick prostration.

Suffering and joy are always accompanied by aversion and desire. The movement of concentration upon self and of the defensive, common to all personal or egotistical feelings, gives to their expression, as M. Mantegazza has remarked, a character essentially concentric or centripetal, while the expression of the benevolent affections is centrifugal and "eccentric." Fear presents the type of the concentric physiognomy pertaining to the affections which have for their center the *me*.

While the feelings derived from aversion are concentric, those derived from desire are expansive. The setting forth of them is expressed by the body, the arms, the head, lips, and eyes, by a tendency to enlargement and touch, the aspect of which is varied according to the nature of the objects and of the possible touch. With joy and suffering, aversion and desire, we have the four fundamental passions, the commingling of which is sufficient to account for all the others, and the expression of which in like manner engenders the most complex mimicry. Physiologists have not taken enough notice of the simplifications which could thus be effected by psychology. The whole can be definitely relegated to a general movement of the will toward the objects or their opposites; and it is the correlative movement of organic expansion or contraction that is the real generator of the language of the emotions.

We pass next to the considerations, ordinarily neglected, that can be borrowed from sociology. When the series of brain-disturbances is produced which have their origin in the appetite or the zest of life, the movement is then inevitably propagated to all the organs. There is in this case, in the first instance, a mechanical contagion, but there is, also, we think, a psychological contagion, and consequently a social phenomenon. The organism, in fact, is a compound of elementary organisms, a society of living cells, united among one another by bonds more or less strict. The cerebral cells being analogous to all the other cells, it is hardly probable that these should not also have their mental side—that is, that they should not be the seat of rudi-

mentary sensations, of vague emotions, and of blind appetitions. In the myriapod it is the head or terminal segment that directs, sees, and smells, but all the other segments also fulfill their appropriate functions, and have their peculiar life in the midst of the collective life. If we cut the animal into several parts, the different parts will continue to move and react under external excitations; it is, therefore, improbable that the head should be the only part to possess sensibility and appetite. When a wound is inflicted upon the animal, it is felt in different degrees by all the segments, and the reaction is propagated from segment to segment. With the superior animals, which are a sort of very centralized states, the concentration of consciousness into the head only obscures the rudiment of sensibility which is still subsisting between the other parts.

For these reasons, we suppose a solidarity of the parts in the living body which, mechanical without, is mental and social within. Hence there can be no irritation of a part without its propagating itself by contagion to all the other parts; this is the germ of the diffused sensation which is felt in the whole body. Furthermore, this irritation being always either favorable or unfavorable to the life of the whole and of the parts, would be felt as rudimentary pain or pleasure—that is, as the germ of the diffused emotion. Finally, all the parts having power to react and a tendency to their own conservation, the irritation brings on a motive reaction of the whole body; this is the germ of the diffuse appetite, of the zest of life inherent in the whole. The solidarity, in the association of living cells, then takes the triple form of a solidarity of extension, of emotion, and of reaction. We could summarize this mutual communication of the organs with the words sympathy and synergy. We think we make a metaphor when we say, "I am suffering all over my body"; but we are only expressing the exact truth: when a part of the organism is suffering, all the other parts feel it by rebound, each according to its importance and its degree of organization. The cry of alarm that issues from the mouth is the translation to the ear of the alarm which is produced not in the brain only, but out to the smallest parts of the organism; it is the cry of an entire people which finds its life threatened. Expression is then a social phenomenon of sympathy and synergy, which is interior to the organism before extending to neighboring organisms.

Thus, we think, is explained the association of similar sensations with one another, and of sensations with emotions. Wundt has insisted upon these two psychological laws, while he has perhaps limited himself too much in establishing them. By virtue of the first law, analogous sensations are associated together; grave sounds have a relationship with somber colors; high tones with bright colors and with white. The sharp sound of the trumpet, and bright yellow and red, correspond. We say, with reason, that there are shrill colors, also that there are cold colors and warm. The reason of these existing

affinities between different sensations is that they can be relegated to a fundamental unity; they are all, fundamentally, excitations and sympathetic reactions of the same primordial appetite.

This fundamental unity explains, we think, the other great psychological law of association, which connects the sensations with analogous emotions—a law which plays a very important part in expression. Wundt has shown that there is something exact in the images of vulgar language—a *hard* necessity, a *sweet* tenderness, *bitter* griefs, *black* cares, a *somber* destiny. These images, so far from being wholly artificial, have their natural origin in the constitution of our sensibility and in the relation of the sensitive organs to the motor muscles. Our sensitive organs are provided with muscles which have the double purpose of better disposing them to receive favorable excitations and removing harmful agents. The mouth takes a different form and expression accordingly as we are tasting a sweetened liquor or swallowing a bitter draught; in the former case, it seems to dispose itself to attract and receive, in the latter to repel and reject. Darkness, a glaring light, a clear daylight, give by turns a different figure to the physiognomy. By virtue of the association of the emotions with similar sensations and of these with their corporeal expression, agreeable or disagreeable feelings—joy, esteem, fear, grief, spite—are manifested by muscular contractions resembling either the action of pleasing tastes and smells, and of the luster of a tempered light, or of bitterness, poisonous odors, darkness, and blindness. If the expression is the same for the physical sensation and the moral feeling, it is because both have their unity, not only in the same field of consciousness, but also in the same movement of the appetite and the will. Whatever the causes and whatever the objects, we simply desire what augments our activity, and repel what diminishes it.

Reciprocally, the willful expression of an emotion which we do not feel, generates it by generating the sensations connected with it, which in their turn are associated with analogous emotions: the actor who expresses and simulates anger ends by feeling it to a certain extent. Absolute hypocrisy is an ideal; it is never complete with a man, realized in full, it would be a contradiction of the will with itself. In every case, Nature is ignorant of it; sincerity is the first law of Nature as it is the first law of morals. So it is with sympathy. Nature knows no isolation of ideal egoism; it brings together, it confounds, it unites. Like heat and light, it can not give life and sensibility to one point without making them radiate upon the other points. Even within the individual organism, it establishes a society; and he who believes himself one and solitary is already several: the *I* is already the *we*. In this way, all the organs, the heart, arteries, nerves, and muscles sympathize with the brain, and tell, each in its own language, of the suffering or enjoyment in which they are participating. In this way, too, the brain sympathizes with the organs, changes their

pain into sadness, and their sensation into feeling; it sends them back its pain and receives it multiplied; a sad thought soon has a *cortége* of myriads of painful sensations, from the movements of the heart and chest to the most superficial parts of the organism.

To the association of analogous sensations or emotions may be referred, we think, the third of the laws of expression, which Darwin has studied without exhibiting its real meaning—the law of antithesis. Some states of mind, says Darwin, induce in the animal certain habitual acts which are useful to the support or defense of life; and when a state of mind of a directly inverse character is produced, the animal instinctively and by antithesis performs the opposite acts, even when they are useless. Physiologists have rejected the Darwinian principle of antithesis, and the examples he cites in illustration of it may generally be explained in another way. But we think the principle has a psychological value which Darwin failed to elucidate. The association of states of consciousness takes place by contrast and antithesis as well as by analogy; contraries as well as similars are subject to a law of association, which is especially manifested in the domain of the emotions. There exists a fundamental antithesis between pleasure and pain, between acceptation and repulsion by the will. An organic connection appears to be established between these opposites, in such a way as to produce a perpetual bifurcation of movements. It is not, therefore, strange that the contrary of a feeling should be expressed by contrary movements or attitudes, aside from all considerations of utility or all choice of the will. This contrast affords a means of facilitating the interpretation of signs.

The law of antithesis is thus a particular case of the law of association, which itself results from the natural concert of all the organs. This concert, or sociality, is so much the essential character of the emotion and its language, that the absence of accord and consonance between all the parts of the organism gives us the means of distinguishing feigned emotions from real. Thus, in theatrical pain, the expression is exaggerated out of all proportion to the occasion, and the real physical condition is so unlike the assumed that the sham is easily detected, and the illusion may be destroyed by a slight accident. On the other hand, when dissimulation of a real emotion is attempted, it is very hard to keep the current of feeling, which is not allowed to express itself in the natural way, from finding vent in some other way, as in mental excitement, or in movements which apparently have no relation to the suffering experienced. Passions on the point of breaking out may be revealed by rhythmical movements of the fingers, or by forced respiration.

Expressional movements, associated according to the laws we have reviewed, end by fixing themselves and leaving traces, not only in passing attitudes, but also in that permanent attitude which constitutes the form of the features. Persons leading the same life, as man-

and wife, sometimes ultimately acquire a similarity of physiognomy. Animals faithfully express the passions of their race in their organs and attitudes; and men, in turn, reproduce in themselves various types of animality. Different races of men have their own respective varieties of physiognomy, according to the predominant traits of their characters, and different nations among men of the same race.

The professions also leave their traces in the forms of the organs and in the features. "The bearing of the soldier," says M. Mantegazza, "is precise, stiff, and energetic; that of the priest, supple and unctuous. The soldier, even in civil life, shows in his movements the habit of obedience and command; while the priest in a lay dress wears the mark of the cassock and the cloth, and his fingers seem all the time to be blessing or absolving." So many other professions may be recognized by their attitudes, but there are limitations in the matter; for physiognomy, as M. Mantegazza says, "can not yet be considered an exact science, because we do not yet know all the elements of the problem. It has, nevertheless, its well-established general laws We are not likely to confound a frank physiognomy with a tricky one, or an honest face with the face of a debauchee or rascal."

There remain a few words to be said on the interpretation of signs, in which the old psychology saw a mysterious faculty. We regard it as the simple continuation in another of the sympathetic contagion, of the solidarity which is first manifested in the interior of an organism. In the exterior as well as in the interior of our body, sympathy is the only psychological law of expression; to interpret is to sympathize. In a mechanical view, this sympathy is a real communication of movements, as when the vibrations of a bell set another bell in vibration; in the psychological and social view, it is a real solidarity of sensations, impressions, and volitions. The instinctive reaction of the will under the influence of the feeling, having been extended by contagion to our whole organism, extends by contagion to similar organisms, and, if other men comprehend what we feel, it is because they themselves feel it. The final result of this sympathetic communication is the retranslation of the emotion felt by one into similar emotions in the others. The emotion of our neighbor is returned to us by a kind of response or return shock. Seeing the movements and attitudes of others, we tend to realize them in ourselves; then, as by a counter-stroke, the movement and attitude realized by us reproduce in us the feelings that correspond to them.

Mr. Spencer would explain the interpretation of signs by a purely mechanical association. This same cause, acting upon several animals simultaneously, makes them, for example, utter the same cry of alarm; the fear and the cry are finally associated mechanically; this association, by the survival of the best endowed, becomes organic and hereditary; at least the mere hearing of the sound of alarm will be enough mechanically to awaken the feeling. While we do not deny the in-

fluence of habit and heredity, we think that this explanation of Mr. Spencer's is still too exterior. There is an intimate connection, both physiological and psychological, between the cry of distress and the distress itself. The part of heredity and selection is simply to augment more and more the kind of internal sonorousness by which one being responds to the emotion of another. And why does this sonorousness become stronger as the being has more intelligence? Because, its power of representation having increased, it can represent to itself with more vivacity what other beings, and in due order itself, feel. But intellectual sympathies are less the true conditions of the affective life than organic sympathies. Intellectual sympathies present a kind of intermittent character; but the sympathies of the organs among one another never wholly cease till death; and from this results a constant necessity for sympathy with others which is the extension of the concert that was begun in our organism.—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

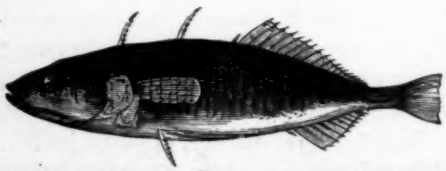
THE THEORY OF TITTLEBATS.

THE last theory of tittlebats of which I remember to have heard anything was that broached by Mr. Pickwick in connection with his profound and celebrated researches into the origin of the Hampstead Ponds. The suggestion of a causal connection between organism and environment, thus implied by the very title of Mr. Pickwick's paper, might lead one to suppose that the philosopher of the Fleet may have been really an early evolutionist, a Darwinian before Darwin, and an unconscious precursor of the now fashionable biologists, who account for everything on the Topsy principle of supposing that it "growed so." For undoubtedly the tittlebat was developed in, for, and by his native ponds, and any comprehensive theory of his existence and history must necessarily begin with the environment that produced him. Unfortunately, however, nothing now remains of Mr. Pickwick's valuable disquisition, except the bare title, enshrined among the posthumous papers of the club that bore his name; and I am therefore compelled, in reconstructing the theory of tittlebats on my own account, entirely to ignore the labors of my distinguished predecessor, and begin again *de novo* from the very outset.

The name itself of the tittlebat, I regret to say, appears in Mr. Pickwick's lost memoir in so debased and corrupt a form as scarcely to be recognizable to the philological student. His true title, I need hardly remark in this age of inquiry, ought to be stickleback; and he is so called in virtue of the stickles, spines, thorns, or prickles which represent and replace the first dorsal fin in all his kindred. But though the stickleback is so small a fish as even to have excited the

scorn and ridicule of our great novelist, he can boast of almost as many *aliases* as the French counts and other sporting gentlemen who periodically return to journalistic fame under the ever-green heading of "The Great Turf Frauds." Besides his recognized literary English name of Stickleback, with its vulgar London variant Tittlebat, he is also diversely known to the ingenuous youth of this kingdom as the Banestickle, the Jack Bannel, the Harry Banning, the Sharpling, the Banticle, the Tanticle, the Hackle, the Sharpnails, the Stanstickle, the Tommy Parsy, the Prickleback, the Barmy, and the Tinker; all names implying at once a certain amount of affectionate regard on the part of his sponsors not uncombined with a due respect (the child of experience) for his remarkable offensive and defensive powers. A true theory of tittlebats would have to account not only for the peculiarities of bony structure which have secured the stickleback these his many names, but also for the oddities of domestic arrangement which I shall further unfold in the course of this article.

The common English stickleback, with whom I propose here chiefly to deal, is a fresh-water fish, much discovered in ponds and small rivers, and abundant everywhere in the neighborhood of London. Many famous anglers, as Frank Buckland used to observe, were first "entered" for the noble sport by fishing for stickleback in the Regent's Canal. The fishing is most frequently pursued in the following fashion: You take a stick with a piece of thread tied to it, and a short bit of worm fastened to the string by the middle without any hook or even a bent pin to represent one. When the stickleback, who is naturally a greedy feeder, approaches the worm, he quickly swallows it, and you pull him up with a jerk before he has had time effectually to disgorge his gulped-down mouthful. Expert anglers at this particular task have even been known to jerk up two sticklebacks at a time, each intent upon one end of the worm; but this is a fine point of science not to be imitated by the uninstructed tyro. The fish, when landed, are consigned to pickle-bottles filled with water, and are commonly sold to the proprietors of domestic aquariums for the small charge of a penny a dozen. In this way, a working acquaintance with the habits and manners and peculiarities of the stickleback has been generally diffused throughout a large portion of the unscientific British population.



TWO-SPINED STICKLEBACK (*Gasterosteus biaculeatus.*)

Nevertheless, I hold it is a fatal error to suppose that the theory of tittlebats falls in any way below the dignity of a profound philosopher. On the contrary, there are points in the psychology and physiology of the common stickleback which merit the close and undivided attention of the most accomplished naturalist.

I will begin with one of the best-known habits of the stickleback, its nest-building instinct; because that is really the one of its peculiarities which most affects the theory of tittlebats, and has the deepest interest and the widest implications for the general reader.

If you put a pair of assorted sticklebacks into a small aquarium, and supply them well with food during the early spring, you will find that after a short time the male fish begins to undergo a remarkable change of personal appearance. His coloration grows brighter and more beautiful; his throat and belly assume a deep crimson hue; his eyes acquire a brilliant bluish-green metallic luster, like the gorget of a humming-bird; and in the well-chosen words of his panegyrist, Mr. Warington, his whole body becomes almost translucent, and seems to glow as with some mysterious internal brightness. It is the season of courtship, and the stickleback is adorning himself in his courting suit.

> "In the spring a ruddier crimson comes upon the robin's breast,
> In the spring the wanton lapwing gets himself another crest,
> In the spring a livelier iris changes on the burnished dove,
> In the spring a young man's fancy lightly turns to thoughts of love."

The name of the stickleback falls unfortunately below the level of the lyrical muse, or else he might perhaps form a fifth member in that lovers' quartet. For no creature decks himself out in more gorgeous nuptial colors, or arrays himself more like Solomon in all his glory against his wedding-day, than the common little Hampstead tittlebat of Mr. Pickwick's missing dissertation.

Theoretically, of course (and we are all on the theory of tittlebats here), this assumption by the stickleback of special colors and ornaments for the pairing-season is all of a piece with the numerous other devices of Nature for securing the due selection by animals of the handsomest, strongest, and most vigorous mates. Many of the more brilliant animals don their finest decorations for the period of courtship only. The crests and lappets of the herons and egrets are developed and retained during the summer alone; they fall off as soon as winter arrives. The African widow-birds deck themselves out in the nesting-season with very long and conspicuous plumes, which disappear again, and leave them as mere inconspicuous little brown birds, after the brood is reared. The crested newt puts on his vandyked head-gear, and dapples his body with orange and crimson spots, at the approach of spring-tide. The speckled trout becomes livelier in hue; the salmon shine with brighter silver; the lizards acquire their metallic throat-pouches. It is at such times alone that the face of the mandrill glows with blue and purple, or that the rhesus monkey blushes a vivid crimson. Throughout the whole of nature, in fact, all the most beautiful animals attain their highest beauty in the season of courtship, and many which are never beautiful at other times then put on the most decorative ornaments or the most gorgeous coloring. This is true alike of the wings of butterflies, and of the song of crickets;

it is true of the gemmeous dragonet and of the butterfly gurnard, of the peacock and the humming-bird, of the bird-of-paradise and the argus pheasant, of the perfume of the musk-deer and the antlers of the stag, of the lion's mane and the monkeys' beards, crests, and gorgets. All alike are assumed for the self-same purpose, and all are useful merely to charm the fickle senses of the proverbially coyer and more uncertain sex.

The stickleback has acquired his gorgeous wedding-garb, in accordance with a general law of animal life, in order to please and attract to himself the attention of his æsthetic and fastidious mates. "After the breeding-season," says Mr. Darwin, "these colors all change, the throat and belly become of a paler red, the back more green, and the glowing tints subside." Moreover, as usually happens in the case of all highly decorated animals, your stickleback further resembles Solomon in being a most undisguised polygamist in the natural state; and his brilliant hues have, no doubt, been developed to charm and draw to his side as many as possible of the female fish. Polygamous animals, in other words, are always handsome, because only the handsomest succeed in attracting to themselves a harem, and so handing on their peculiarities to future generations. Furthermore, the sticklebacks are all great fighters; and it may be broadly laid down once more as a general principle of animal life, and at the same time a contribution to the theory of tittlebats, that all very handsome and decorated creatures are naturally pugnacious of disposition. Thus stags fight one another with their branching antlers for the possession of the does. Salmon constantly join battle and tear one another to pieces savagely on the recognized spawning-beds. The polygamous ruff, distinguished from his sober-suited mate the reeve by his curious crest, and by the great collar of plumes from which his name is taken, is as full of the Homeric joy of battle as a game-cock, and quite as gamy. The wild Sumatran ancestor of our own barn-door fowl "does battle in defense of his seraglio till one of the combatants drops down dead." Blackcock and capercailzie assemble annually at regular tournaments, to fight one another, and display their beauty before their expectant and undecided dames; and on such occasions Kovalevsky has seen the snow of their arenas in Russia all red with blood, and covered with the torn-out feathers of the champions. Most of the handsomest birds and animals, indeed, are provided with special weapons for these fierce encounters, such as the spurs of game-birds, the horns of antelopes, the antlers of stags, the tusks of the musk-deer, the wing-darts of the palamedia, and the fierce spiny fins of the most decorative fishes. Even the dainty little humming-birds themselves are prodigious fighters, and I have seen them engaging one another in their aërial battles with the utmost pluck, vigor, and endurance. Furthermore, beauty in animals is almost always accompanied, as Dr. Günther has observed, by a very hasty and irritable temper.

And now, I think, we are beginning to get a little nearer toward the theory of tittlebats. For the male stickleback is a prodigious warrior, and, when he meets a rival of his own kind, he engages with him at once in deadly warfare. Their battles, says Mr. Darwin, are at times desperate, for these puny combatants fasten tight on each other for several seconds, tumbling over and over again, until their strength appears utterly exhausted. Bold and pugnacious as they are, however, it is only my lords who thus fiercely contend with one another; their demure little mates remain always perfectly pacific, gentle, and even-tempered. With the rough-tailed stickleback, the males while fighting swim round and round one another, biting and endeavoring to pierce each other's mailed skin with their raised lateral spines or lances. Small as they are, their bite is very severe, and inflicts a deadly wound upon their antagonist; and Mr. Noel Humphreys remarks that they use their lateral spines with fierce effect, so that he has seen one brave stickleback during a stout battle rip up his opponent from end to end, till the vanquished hero sank to the bottom and died ingloriously.

It is during the moment of battle, and just before and after it, that the colors of all fighting animals become invariably most intense. The reason is plain: battle is joined during the mating-season, and "before the face of maidens and of dames"; and, as in human tournaments, the ladies stand by to applaud the conquerors and to reward their prowess. They are themselves the prize of the encounter they stimulate. Besides, the highest physical vigor and the highest excitement bring out the greatest beauty both of men and animals. The angrier you make a mandrill, the more vividly tinted are his cheeks and callosities. The frilled lizards and flying-dragons glow with all the brightest colors of the rainbow when you tease or annoy them. The turkey-cock swells his crimson wattles and spreads his ruffled feathers to the utmost at sight of a rival or a mischievous boy. There is a little hot-tempered fish known as *Betta pugnax*, and kept as a sort of domestic pet by the Siamese (much as the Christian English gentleman of forty or fifty years since kept fighting-cocks) to display its prowess for the edification of the Mongolian intelligence. "When in a state of quiet," says Cantor, "its dull colors present nothing remarkable; but if two be brought together, or if one sees its own image in a looking-glass, the little creature becomes suddenly excited, the raised fins and the whole body shine with metallic colors of dazzling beauty, while the projected gill-membrane, waving like a black frill round the throat, adds something of grotesqueness to the general appearance. In this state, it makes repeated darts at its real or reflected antagonist. But both, when taken out of each other's sight, instantly become quiet." The fighting-fishes, as the Siamese call them, are kept in globes like gold-fish, and fed from time to time with the larvæ of mosquitoes. The Siamese are as wild after their combats as the Malays are for

cock-fighting, and often stake large sums, or even the freedom of themselves and their families, on the prowess and skill of a particular betta. The license to exhibit fish-fights is farmed by Government, and brings in a considerable revenue to the King of Siam.

Now, much the same thing happens on a lesser scale during the battles of the sticklebacks with their pugnacious rivals. It is then especially that their bodies assume the beautiful transparent and iridescent colors so poetically described by Mr. Warington. Their vitality rises to its highest point, and their eyes sparkle like a girl's at a ball with the most vivacious brilliancy. But when a hapless stickleback is conquered in the lists, says Mr. Darwin, "his gallant bearing at once forsakes him; his gay colors fade away; and he hides his disgrace among his peaceable companions, but is for some time the constant object of his conqueror's persecution."

It is pretty clear, then, that the stickles and lateral spines of the stickleback have been mainly developed, like the spurs and wing-weapons of birds, the tusks of boars, the antlers of deer, and the horns of lizards, for the purpose of combating rivals in these annual contests, and of securing the favor of the female fish. The same thing is also true of their beautiful colors, or rather, both are but different sides of the same question; for, as Mr. Wallace has shown, the most beautiful animal is also the strongest and most efficient, and the periods of high vitality are always accompanied by the most ornamental developments and the most vivid coloring. From generation to generation, the strongest, best armed, and most brilliant sticklebacks have conquered the feebler or uglier in battle, and have been selected as husbands by the greater number of their fastidious mates. None but the brave deserve the fair; and, among sticklebacks, none but the brave succeed in winning them. I do not doubt that the stickles also prove incidentally useful to the fish in protecting him from the attacks of larger predatory species; sticklebacks are seldom attacked by perch or trout, and an instance is on record where a pike has been choked by one of these tiny creatures, which erected its sharp spines in his throat as the greedy monster tried to swallow it; but this secondary purpose is only a derivative one; the spines themselves must originally have been developed, as in all other cases, for the wedding tournaments between stickleback and stickleback. It is thus that the horns and tusks of higher animals primarily produced in the internecine combats of the males are occasionally employed for external defense; thus that the spurs and beaks of birds are occasionally turned to the protection of their fledglings. But it may be laid down as a general law of biology, in spite of misconceptions and misstatements to the contrary, that no animal habitually and normally fights any other creatures except individuals of its own species. Dog fights dog, and tiger tiger; but game-cocks do not engage with turkeys, nor do stags usually join battle with buffaloes or bears.

As soon as the pairing-season sets in, the first care of the male stickleback is to provide a nest for his wife and children. For the stickleback is just as much a nest-builder as any bird; only, he does all the work himself, instead of being aided, as birds usually are, in

STICKLEBACKS AND THEIR NESTS (*Gasterosteus aculeatus*).

the task of nidification, by his attentive partner. He begins by busily collecting a quantity of delicate fibrous material, the tissues of water-weeds or of macerated land-plants, which he mats with his mouth into an irregular circular mass, somewhat depressed, and about an inch and a quarter in diameter. Then he covers the top with similar materials, and leaves in the center of one side a large, round aperture to act as a

doorway. As he mats the fibers together by creeping over them with his body, he cements them firmly with the slimy mucus that exudes from his skin. He is a quick worker, not to say a jerry builder (any one can watch the whole process easily for himself in a fresh-water aquarium), and he only takes a few hours in getting the entire residence completed from basement to coping-stone. As soon as it is finished, the little architect sets out on his quest of a partner or partners ready to occupy it. If he meets a rival on the way, the two small Turks fight out their differences at once on the spot, while the bride-elect amicably stands by expectant, and accepts the conqueror. When she emerges from her hiding-place under the waving weeds and comes out, the guerdon of his prowess, to survey the nest he has deftly woven for her, the tiny sultan positively dances and curvets around her, "mad with delight," as an acute observer has well worded it. "He darts round her in every direction; then to his accumulated materials for the nest; then back again in an instant, and, as she does not advance, he endeavors to push her with his snout, and then tries to pull her by the tail and side-spine to the nest." Indeed, there is a deal more that is human and natural in the lives of all these little despised creatures than the people who laugh at theories of tittlebats have ever stooped to notice or discover.

As soon as the stickleback has duly inducted the partner of his choice with many caresses into the home he has built for her, or rather for her offspring, he introduces her by the door he has left in the side into the closed chamber. In a few minutes the bride has laid two or three tiny, transparent yellow eggs, after which she bores a hole with her snout on the side of the nest opposite to that by which she entered, and makes her exit, a divorced wife, without further formalities. "The nest," says Dr. Günther, "has now two doors, and the eggs are exposed to the cool stream of water, which entering by one door flows out at the other." This, of course, by keeping up a fresh and constant current, supplies them with the oxygen necessary for hatching. Next day, the little sultan goes out again in quest of a fresh mate, and brings back his new bride to add a few more eggs to his stock of spawn. This operation he repeats daily until the nest is nearly full; and then the fond father sets to work himself at the congenial task of incubation. For among fish it is almost always the male, not the female, who sits upon the eggs and charges himself with the care and education of the young fry.

For the subsequent stages, I can not do better than quote Frank Buckland's animated account of a case observed by the learned curator of the Norwich Museum. "Nothing," says the genial naturalist and angler, "could exceed the attention from this time evinced by the male fish. He kept constant watch over the nest, every now and then shaking up the materials and dragging out the eggs, and then pushing them into their receptacles again and tucking them up with his snout,

arranging the whole to his mind, and again and again adjusting it until he was satisfied; after which he hung or hovered over the surface of the nest, his head close to the orifice, the body inclined upward at an angle of about 45°, fanning it with the pectoral fins, aided by a side motion of the tail. This curious manœuvre was apparently for the purpose of ventilating the spawn; at least by this means a current of water was made to set in toward the nest, as was evident by the agitation of particles of matter attached to it. This fanning, or ventilation, was frequently repeated every day till the young were hatched; and sometimes the little fellow would dive head foremost into his nursery and bring out a mouthful of sand, which he would carry to some distance and discharge with a puff. At the end of a month the young ones were first perceived. The nest was built on the 23d of April; the young appeared on the 21st of May."

After the young are actually hatched, the fond parent only redoubles his delicate attentions. He never leaves the precincts of home by day or night; and he guards the nest with the utmost pertinacity, allowing no stray intruder from any side to approach it. If a greedy water-beetle or other enemy comes near the young, this exemplary father runs full tilt at him with his armed spines, pounces upon him broadside, and unceremoniously shoves or tumbles him over. If you try to disturb him in an aquarium with a stick or pencil, he will charge at it smartly, and strike it so hard that the blow can be distinctly felt by the hand that holds it. Among the enemies he has to repel on such occasions, I regret to say (for the honor of maternity I would fain conceal the fact), are the mothers themselves of his little charges, who wish to emulate Saturn and the common rabbit by making a dinner off their own flesh and blood. "For a whole month," says Dr. Günther, "he watches over his treasure, defending it stoutly against all invaders, and especially against his own wives, who have a great desire to get at the eggs." Those unnatural parents, indeed, make such a dead set upon their young and the devoted father who guards them, that, as Mr. Darwin cynically observes, "it would be no small relief to him if after depositing their eggs they were immediately devoured by some enemy, for he is forced incessantly to drive them from the nest." Let us trust that the wedded stickleback himself never indulges in such uxoricidal fancies.

The fry, when hatched, are at first so very minute and transparent that you can with difficulty perceive them in the water of an aquarium, and even so only by the gentle fluttering motion of their wee fins. Their good papa continues, however, to perform the duties of a nurse for them with profound vigilance, confining them at first to the meshes of the nest, and, when they stray too far, gently leading them back with unremitting kindness to the path of duty. By degrees, as their knowledge of the world increases, he wisely allows them to indulge in greater excursions, and hollows out for them a small basin in the sand

of the bottom, where they may disport themselves at their ease until they grow strong enough to venture on a wider range of thought and action. If rival papas or hungry mammas attempt to devour them, he falls upon the assailants in a violent fury, and carried away, it would appear, by the warmth of his feelings, occasionally goes so far as actually to indulge in acts of cannibalism. For this I do not commend him. No amount of ethical enthusiasm can ever justify a truly moral being in devouring the persons of his fallen enemies.

Fellows of the Royal Geographical Society are probably aware that in the neighborhood of London, and more precisely through the parish of Wandsworth, there flows a minor tributary of Thames, by name the Wandle. This stream, as the sportive youth of South London know full well, abounds in sticklebacks of all ages and sexes; and here it was that Mr. Smee, one of the chief contributors to the modern theory of tittlebats, first observed their habits and manners. "They are very pugnacious and cunning creatures," says he, in his charming work, "My Garden." "They build a nest and protect it. In the middle of May I observed a stickleback evidently guarding a circle of about two inches in diameter, and chasing away every other fish which came within his domain. On closer examination, I saw at the bottom a small circular plate of the same size, made of fiber, but arranged level with the bed of the stream. Suspecting a nest, I carefully raised it, when it proved to contain two parcels of eggs, which were about the size of a large pin's head. I immediately replaced the material as well as I could in its former place; but the stickleback was not at all satisfied with my arrangement, and set to work diligently to adjust it himself. He brought little bits of fiber and thrust them into the mass, and rearranged the larger fibers. When he was perfectly satisfied with what he had done, he mounted guard and rushed at any other fish which came near him. Afterward, I found these nests by scores, each protected by its guardian stickleback; and in the month of May I can always delight my visitors by showing them a nest presided over by the pugnacious little fish." I may add that similar nests are to be found in almost every brook or pond in England at the appropriate season: only, you must be born with the proper eye for seeing them. It is not every man who can discern stickleback. I once conducted a statistical survey of all the lizards inhabiting Great Britain and Ireland, and came to the conclusion, as the result of my census, that the lacertine population of the United Kingdom numbers at least two hundred million, or more than five times the human beings; and yet how often most people on their walks abroad meet a man, and how very, very seldom they happen upon a lizard!

Sticklebacks are not by any means the only fish which thus take care of their helpless progeny during the first weeks of infancy. It must be remembered that our acquaintance with the domestic habits

and manners of fishes, and especially of the marine species, is but sporadic and fragmentary; opportunities for observation are rare on the sea-bottom, while, as for aquariums, the life there is so strained and unnatural that we learn for the most part little more from that source than one would learn of the intricacies of human existence by watching the interiors of prisons and of convents. But even among the few fish at all intimately known to us at present, there are several which deserve high commendation for their able and conscientious discharge of their paternal duties. Certain cat-fish, for example, and many other species, construct nests like good fathers, and guard the spawn deposited in them by their unnatural spouses. One siluroid bearing the suggestive classical name of Arius actually carries the eggs about with him in his own mouth, and there devotedly hatches them. There is a fish of the Sea of Galilee, locally supposed to be the very kind from whose mouth St. Peter took the miraculous denarius for the payment of the apostles' tribute, and this pious and well-principled creature (even his scientific name is *Chromis sacra*) holds his eggs in the same fashion, and hatches them out in his capacious pharynx. Among the pipe-fish and sea-horses, including the well-known hippocampus of the Mediterranean and the Westminster Aquarium, Nature has gone one step further in the direction of parental supervision. These fish have a regular pouch like the kangaroo, in which the excellent papa retains the young till they are of full age to shift for themselves.

Yet even here it is the fond father, not the gay and careless mother, who wheels about the family perambulator: only two known cases occur among fish where the mother takes any part at all in the hatching or education of her own young. One is a cat-fish from British Guiana, whose under surface becomes soft and spongy after the spawning-season. The mother, as soon as she has laid her eggs, presses them hard into this spongy integument by lying on top of them. There they stick, and she carries them about in the pits thus formed, much as the familiar Surinam toad carries about her hatching ova and tadpoles in the skin of her back. The other instance is that of a singular pipe-fish from the Indian Ocean, who forms a pouch for her young by allowing her ventral fins to coalesce with the soft skin of her under surface. These two examples of devoted maternity, however, scarcely suffice to absolve the mother-fish as a class from the general charge of heartless desertion brought against them by modern ichthyologists.

It is worth while, perhaps, to note in passing (since a theory of tittlebats is nothing if not exhaustive) that the eggs of stickleback are larger in proportion to the size of the full-grown individual than those of any other known fish. Why is this? Simply because the stickleback are good fathers, who take great care of their callow young. (I don't know what callow means, as applied to a fish, but I

feel sure it is a neat and appropriate epithet.) Where the chances of infant mortality rule high, the mother-animal must produce vast numbers of small and ill-supplied eggs in order to provide against the adverse possibilities. That careless parent, the cod, who lays her spawn unprotected upon the shallow banks, for thousands of greedy enemies to devour, often produces at a single birth as many as from four to nine million separate eggs. But just in proportion as the eggs and young are more efficiently guarded and provided for in life does it become possible to economize in the number of germs originally produced, and to give each at the outset a fair supply of yolk to start well in life with. Compare the myriad tiny black seeds of the poppy, which take their even chances anywhere that fate may carry them, with the richly stored bean or pea or filbert, well provided with nutriment for the growing seedling, and you will see at once the force of the analogy here intended. The codfish lays a great many ill-supplied eggs, and lets them shift for themselves in the open sea as best they may, on the off chance of one among four million or so reaching maturity; the stickleback lays comparatively few large and well-supplied eggs, but the amiable father watches with tender solicitude over the safety of all, so that on an average two at least out of each mother's small brood must needs survive to years of adult sticklebackhood.

I have spoken of the stickleback genus so far as though, like the French Republic, it were one and indivisible. Such, however, is not the case. The family has split up into several minor sections, each adapted to particular situations. There are some ten known species of stickleback, and the facts hitherto noted apply most especially (save in a few instances) to one above all others among them, the common British three-spined stickleback. All the varieties are pretty much alike in all essential points, having the same long, flat-sided bodies, with hard cheeks, while parts of the skeleton usually form an external coat of mail, and grow out into large scutes or shields along the sides. On their back are more or fewer of the spines from which the entire group take their generic name, nine in one species, fifteen in another, three only in the commonest English form, and no more than two in the pretty little North American example. One of them has adapted itself to brackish water and the open sea; the others are all fresh-water forms, though most of them at a pinch can manage a sea-voyage without serious damage to their constitutions. They are a north temperate family by origin; in other words, they have sprung up in the rivers of the sub-Arctic zone, and have not yet spread beyond the Arctic and temperate regions of the northern hemisphere on both sides of the Atlantic.

Our common little British river stickleback, the familiar tittlebat of the Serpentine and the Hampstead Ponds, is the three-spined form (*Gastrosteus aculeatus*); and he has generally, in addition to his offensive spines, a series of defensive shields or plates along the gleaming

side of the body. In Central Europe, however, these shields generally disappear, I suppose through the absence of some dangerous enemy to whose attacks the little creature is habitually subject in our British waters. This last idea, however, must be accepted as purely theoretical, for I can not suggest who that enemy may be. The three-spined stickleback is a very active and voracious little fellow, exceedingly destructive to the fry of carp or trout, and therefore, of course, highly detrimental in ponds where the preservation of larger fish is a matter of interest. It is scarcely to be conceived, says our great piscicultural authority, Dr. Günther, what damage these little creatures do, or how prejudicial they are to the increase of all the other fishes among whom they live. Their industry, sagacity, greediness, and success in seeking out and destroying all the young fry that come in their way are indeed simply marvelous. To take a single instance, a small three-spined stickleback kept in an aquarium devoured in five hours' time, by actual observation, seventy-four young dace, each a quarter of an inch long. Two days after, the same unconscionable little gourmand swallowed sixty-two, and seemed as hungry at the end of that bout as if he had never tasted breakfast. Considering that stickleback sometimes simply swàrm in rivers, ascending them *facto agmine* in amazing shoals, the damage they are calculated to do to the trout and bream fishery can only be adequately known to Professor Huxley, who has long and truly urged that the number of fish caught or destroyed by man's will sinks into what the French scientists call *une quantité négligeable* by the side of the havoc everywhere wrought through the natural enemies of each species.

Our other native British fresh-water kinds are the nine-spined stickleback (commonly called the ten-spined out of pure cussedness) and the four-spined, also known as the smooth-tailed, though authorities differ much as to the division of species, some making many and some few. The nine-spined variety is a very small kind, more or less estuarine and semi-marine in his tastes, a frequenter of the river-banks about Southend and Chatham, and much given to migrating in shoals up the creeks and backwaters in early spring. He can also generally be discovered at the Ship or the Trafalgar during the fish-dinner season, trying to pass himself off in good company as a distinguished fish among a plateful of whitebait; but his imposture may be easily detected by observing the tiny stickles on his back, which are too small, indeed, to make him unpleasant eating, but quite big enough to prevent him from giving himself any aristocratic airs on the strength of his resemblance to a parliamentary delicacy. His sides are perfectly smooth and unprotected, and he may be investigated by the curious, nest and all, nearly everywhere among the brackish marshes of the Thames estuary.

The fifteen-spined stickleback or sea-adder is our one marine English species, common on many parts of the British coast, and specially

observed by competent naturalists in Cornwall and the Orkneys. This salt-water descendant of the little river tittlebat grows, as might naturally be expected, to a larger size in his more spacious environment, and reaches the dimensions of an average trout. He never ascends rivers, even to spawn, but weaves his nest of sea-weed or corralline under some overhanging ledge, and guards his bright, amber-colored eggs with the same jealous care as his fresh-water relations. His personal appearance is chiefly remarkable for the very elongated form which procures him the name of adder, as well as for the prolonged snout, not unlike a gar-fish, and the rows of shields that protect his side with a perfect coat of sheeny sheet-armor. That admirable observer, Mr. Richard Couch, of Mevagissey, to whom, with Mr. Jonathan Couch, we owe most of our knowledge of marine fish-life, was the first to watch his manner of nesting. He found that the marine stickleback built its home in shallow water, where the bottom was thickly covered with sea-wrack, and that it bound the materials together with an elastic thread, resembling silk, which hardens by exposure to water, but the mode of whose secretion has not yet been determined. Mr. Couch visited one of the nests every day for three weeks, and saw the parent stickleback invariably mounting guard over it with military precision. When he ventured to disturb part of the materials, the fish immediately set about repairing the damage, by drawing together the sides of the opening, so as to conceal once more the eggs which the too curious naturalist had exposed to view. Stickleback will tolerate no eaves-dropping intrusion into the sacred privacy of domestic life. Society journalism is quite unknown among them.

These few remarks complete in outline the theory of tittlebats which I venture tentatively to suggest in substitution for Mr. Pickwick's lost and lamented essay. As its moral may not be immediately apparent to the young, the gay, the giddy, and the thoughtless, I shall not hesitate to append one in the undisguised form borrowed by modern ethical writers from Æsop's fables. If any of my didactic reflections scattered through the text shall have induced only one serious stickleback to abandon polygamy or to renounce cannibalism, I shall feel that this article has not been written in vain.— *Cornhill Magazine.*

PROFESSOR T. B. STOWELL advocates the study of natural history in secondary schools because of the adaptability of the subject to insure accuracy in perception, the use of a technical and exact vocabulary, ability to weigh evidence, and the power to classify and generalize. The field is so large and grows so fast that the experienced teacher finds his most difficult task in deciding what not to teach. As in all other branches teachers are supposed to have had some special preparation, so the same qualifications should be required in the teacher of natural history as in the teacher of language, and a corresponding proportion of time should be given to science studies. "With such instruction," says the author, "he will let results establish the claims of natural history in the curriculum of secondary schools."

SKETCH OF KARL WILHELM SCHEELE.

THE life of Scheele affords a most conspicuous example in the history of science of a worker who has accomplished great things with the most limited resources. "We stand astonished," said Professor Clève, in his oration at the celebration of the one-hundredth anniversary of the chemist's death—from which we have derived most of the materials for this sketch—"that a man who only reached his forty-third year should have been able, during his short life, always tormented by material wants, to have arrived, by means restricted and inconvenient, at results which have had so mighty an influence on chemistry." Dumas, comparing him with Lavoisier and Priestley, has said of him that "brought up in a pharmacy, poor and modest, unknown to every one, and hardly knowing himself, inferior to the former but superior to the latter, vanquishing Nature by the force of patience and genius, he snatched her secrets from her and assured an eternal fame for himself."

KARL WILHELM SCHEELE was descended from an old family of German origin, and was born at Stralsund, Sweden, December 9 or 19 (authorities differ), 1742. He gave no particular promise in childhood, but was considered "slow," and only moderately intelligent. He took no part in the sports of his brothers and sisters, but amused himself with making all sorts of little objects, and would appear greatly pleased when any of his devices proved successful. His instruction began early at home, and he was at a later period given the usual course at the gymnasium in Stralsund. He became interested in pharmacy through the influence of two friends of the family; and, when fourteen years of age, he was entered as an apprentice with Bauch, a pharmacist of Gothenburg, where he soon found himself at home. A friend suggested to him to study chemistry, and his real vocation was revealed to him by the reading of the works of Neumann. From these he advanced to the works of Lémery, of Stahl, the author of the theory of phlogiston, and of Kunkel, the discoverer of phosphorus. He used to repeat secretly at night the experiments he read about in these books, and thus accustomed himself early to do the works of the masters over again with the most scanty and imperfect materials.

After six years of apprenticeship and two years longer of residence in Gothenburg, Scheele became engaged at Malmö, with the pharmacist Kjellström, who, having himself a taste for experimental chemistry, could sympathize with him. He spent his spare money in buying books upon this science; and it was during his residence here that he made the researches on the *Sal acetosellæ* that led up to the discovery of oxalic acid. He sent a memoir on this subject to the Academy of Sciences at Stockholm, which Bergman, to whom he intrusted it, withheld, because, he said, it contained nothing new.

In 1768 he obtained a place in a pharmacy at Stockholm, where he was not allowed any part in laboratory-work. He would make experiments, nevertheless, and so he studied from the windows of the shop the effects of sunlight upon different bodies. He made himself known, too, at Stockholm as a skillful chemist, and formed friendships with the distinguished scientific men of the time. In 1770 he removed to Upsala, where he was installed director of the laboratory-work in a pharmacy, with permission to continue his own experiments.

Forbern Bergman was then Professor of Chemistry in the University of Upsala, and the two men were soon brought into association. Scheele's master had remarked that, on exposing melted saltpeter to a continuous heat, a salt is developed which, on adding acetic acid, gives out red vapors. Neither the chemist Bergman nor the mineralogist Gahn could explain the phenomenon. Scheele had an explanation. He said that the heated saltpeter absorbed phlogiston (is reduced, as we would have it), and gave the salt of a new acid (nitrous acid), which is weak, and can be expelled by acetic acid. Gahn told Bergman of this explanation, and he sought an introduction to the young pharmacist. Thus was laid the foundation of a lasting friendship and co-operation between the two.

In 1775 Scheele obtained the direction of the pharmacy of Köping, whose proprietor had just died, leaving the concern to his widow. This gave him a more comfortable subsistence than he had enjoyed before, although his task in keeping the establishment in good condition and paying up its debts was hard enough. Yet he wrote to one of his friends at about this time: "You may think, perhaps, that material cares are going to absorb me, and take me away from experimental chemistry. Not at all! That noble science is my ideal. Be patient, and you will soon have something new to learn." He was much annoyed about six months afterward by some one coming to buy the pharmacy, and offers of other positions came to him from every side, among them an offer of the superintendency of a distillery, and invitations to Stockholm, Berlin, and London, with salaries that would have been tempting to common men. But the people of Köping said that they would have no pharmacist but Scheele; and he declined all the invitations, saying: "I can not do more than eat my meat; if I can do that at Köping, I need not seek it elsewhere"; and, in reference to an offer which had been made to him from Berlin: "After mature reflection, I decline it. I lack considerably of being as far advanced in chemistry as such a position requires, and I am persuaded that I shall find my daily bread even at Köping."

During his residence at Köping he only gave himself a single vacation, when he went to Stockholm to attend a meeting of the Swedish Academy of Sciences, of which he had been elected a member in 1775. It was the only meeting of the Academy he ever attended, although nearly all of his papers were published in its proceedings.

Bergman presided on that day, and received Scheele in the name of the Academy, addressing him in terms of warm eulogy. It was on this occasion that Scheele read his paper on the preparation of calomel. He had just passed his examination as a pharmacist, and received an authorization, free of charge in consideration of his services, to keep the shop at Köping. Bergman, in the same year, secured for him a pension of one hundred riksdalèrs to encourage and assist his investigations in chemistry, which was continued till his death.

Scheele had now before him the prospect of an easier future. But, although he had never before been ill, he had an attack of gout toward the end of 1775. He nevertheless continued his studies. In February, 1786, he sent to the Academy of Sciences his memoir on gallic acid. In the same month he was attacked with phthisis; and this disease ended with his death on the 21st of May of that year, two days after he had married the widow of his predecessor in the pharmacy.

Scheele was a man of medium stature and vigorous constitution, and was as modest as he was deservedly famous. Thus he wrote to a friend on the occasion of his being elected to the Academy of Turin: "I really believe they think that I am one of the greatest chemists of the time, and they might make me proud. If they keep on in this way, I might come to think I had as much experience and genius as Macquer and Bergman. But I believe, in truth, that those worthy men have more knowledge in their fingers than I have in my head." His education was not extensive, but he had been accustomed from his youth to think independently and without prejudice, and to verify his conclusions, and never to believe any assertion in chemistry till he had personally tested its validity.

There were no grand, elaborately furnished laboratories in those days, and nearly all the great chemists who did so much to put the science on a firm foundation began their work in pharmacists' shops. Scheele's apparatus was of the most simple character, and included a few retorts, common bottles and flasks, and, for experiments on gases, bladders. To collect a gas, he fastened the bladder tightly to the neck of the retort, in which the chemicals for the development of the gas had been placed. If he had to deal with such a gas as nitrous oxide, he saw that the interior of the bladder was well imbued with oil. He usually employed wooden tubes instead of glass ones, lining their interior with a goose-quill. It would be discouraging to a young chemist of to-day to be limited to such apparatus; but Scheele made up for what was wanting in his tools by his remarkable faculty of observation, perseverance, and keenness of discernment. In his experiments he observed all of the slightest details, and went so near to the bottom of things that he left very little for others to discover in any of the work that he did.

Scheele's scientific labors were performed in different fields of chemistry—general, inorganic, organic, and physiological. The "Treatise

on Air and Fire" was written in 1775, and published in German in 1777; was translated into English in 1780, and into French in 1781. It contained many facts of great value, together with theories on the nature of combustion, fire, light, and heat, which can have now only historical importance. His researches on the subject, although they were parallel with those of Priestley, and although Priestley anticipated him in the discovery of oxygen, were conducted without any knowledge of what the English chemist was doing. Scheele showed in his treatise, from numerous simple and ingenious experiments, that air is composed of two gases, in a proportion, as he calculated, of about three to one; and he described the special properties of oxygen and nitrogen, as we know them, with their effects on combustion and on animal and plant life.

From experiments with "black magnesia," or the binoxide of manganese and saltpeter, now familiar to all students, Scheele deduced the theory that heat was a combination of phlogiston and oxygen, while combustion was the combination of the oxygen of the air with the phlogiston of the combustible body, resulting in the formation of the compound above named, or heat. Light was also a combination of oxygen and phlogiston, but richer in phlogiston than heat. The different kinds of light were different combinations of oxygen and phlogiston—an assertion which was based upon the fact that violet light exercises a stronger decomposing influence on the chloride of silver than does light of the other colors. Thus Scheele was the discoverer of the fact which is the basis of photography. He found that fluor-spar became phosphorescent when heated moderately, but not when heated to incandescence. This was because the mineral contains phlogiston, which, under a moderate heating, unites with the heat and forms light; but when heat is applied to the degree of incandescence, the phlogiston is all taken away and light can not be formed.

Hydrogen, or inflammable air, as it was then called, he regarded as composed of phlogiston and heat. But after Lavoisier, Cavendish, and Priestley had shown that water is produced by the combustion of hydrogen, and hydrogen is formed by passing the vapor of water over incandescent iron, Scheele changed his theory of oxygen, and assumed that it was composed of a *saline principle* of water and phlogiston; of these components, the former gave heat with phlogiston, and water caused an increase in the weight of the burned body. These theories attracted much attention at the time; but they are no part of science, for they were quickly dispelled by the publication of Lavoisier's more correct views on combustion. But the facts which Scheele sought to explain by them—nearly all his own discoveries—remain, valuable gifts to chemistry.

His experiments with fluor-spar, carried on in the course of his investigations on light, led to the discovery of hydrofluoric acid, and its property of acting on glass. In the course of three years' researches

on *black magnesia*, or the binoxide of manganese, which M. Clève suggests may have been the most important that he made, he discovered that the basis of the mineral was a new fundamental body, manganese; that it contained, as an impurity, a new earth, baryta, and that when it was treated with muriatic acid another new substance was evolved, chlorine. Further experiments with the last substance revealed its bleaching qualities, which have been so extensively applied in the arts. Finding that the presence of white arsenic helped the solution of the oxide of manganese in acids, he experimented with that body, and discovered the more important arsenical compounds. Scheele discovered that phosphorus was the cause of cold-shortness in iron, and showed that argillaceous earth was distinct from silicious earth, and not an acid-worked modification of it, as had been supposed. He experimented with plumbago, and found that it was "a kind of mineral sulphur or carbon, composed of carbonic acid and a large quantity of phlogiston," or, as we would express it, of carbon, and showed that it was the insoluble substance that occurred in cast-iron, thus opening the way to the further researches that have been made in the differences between iron, cast-iron, and steel, which, still under prosecution, lie at the foundation of our greatest industries. Connected with this investigation, on account of the resemblance of the minerals to graphite, were his researches in molybdenum and in wolfram. The last resulted in the discovery of the metal tungsten, for which the name *Scheelium* has been proposed.

Very little was known of organic compounds in Scheele's time. It is one of his great titles to merit that he first opened the way to the rich field of the fruitful and enriching discoveries that distinguish the medical and industrial chemistry of our day. The first in order of his researches in this line is his memoir on Prussian-blue, which well illustrates the readiness with which, bringing his extraordinary penetration to bear, he was able to arrive at the truth. In the course of his research he obtained a colorless liquid, which he described as "a substance having a curious odor, but not disagreeable, with a taste somewhat like that of sugar, which heated the mouth slightly and provoked coughing." He little imagined that he had in his hands one of the deadliest poisons known, prussic acid; and we shudder when we think how near it might have come to making an end of him. His researches on the different species of alcohol, described in 1782, indicate that he obtained aldehyde, a substance which has since been the starting-point for numerous important combinations, but of which the discovery is attributed to Liebig, in 1835; he appears also to have encountered chloral in his researches.

The preparations made in his shop led Scheele, in 1783, to the discovery of glycerine, which was at first called Scheele's sweet principle of oils. Boiling oxide of lead with water and oils, he obtained a plaster which he called a kind of hard soap, and which was not

soluble in water. Examining the liquid which was left, he observed glycerine.

In a memoir relative to a new method of preserving vinegar (1782), Scheele showed that further change could be prevented by bringing the vinegar to the boiling-point. Scheele was the first to examine the substances which give an acid taste to fruits and plants. To this order belongs his examination of the "salt of sorrel." He also, in one of his earlier scientific labors, isolated tartaric acid, and introduced the method by which numerous other organic acids have since been separated. In 1784 he discovered citric acid in the lemon, gooseberry, and other fruits, and malic acid in the gooseberry and in fruits generally; and shortly before his death he produced gallic acid, or "salt of gall-nuts," from which he distilled pyrogallic acid, which has been found useful in photography. He first found benzoic acid, saccharic acid, and mucic acid. Examining what was called rhubarb-earth, in 1784, he found it to be composed of oxalate of lime, and from this proceeded to show that that substance is generally present in roots and bark.

In animal chemistry, he examined the concretions of urinary calculus, discovered uric acid, observed its connection with intermittent fevers, and prepared alloxane and cyanuric acid. In 1780 he investigated the phenomena of the curdling of milk, and speculated as to its cause, and in this research discovered lactic acid.

Scheele's nomination as member of the Royal Academy of Sciences, in 1775, is said to have been the only public mark of distinction he received in his native land. He was elected to the Society of Naturalists in Berlin, in 1778; and of the Academy of Sciences of Turin, in 1780, in the presence of his king, Gustavus III. His Majesty, it is said, had not heard much of Scheele before this, and was a little astonished, on hearing the eulogies passed upon the newly-elected member, to hear what a great man he had in his states. He was sorry that he had done nothing for him, and decided to make amends; he would confer an order upon him. The minister to whom he gave his directions was puzzled, for he, too, did not know Scheele. The order was conferred—but upon another Scheele than the chemist!

Scheele's collected works were published at Leipsic, in Latin, in 1788–'89, and in German in 1793. His papers in the Royal Academy have been translated into English by Thomas Beddoes, and are published under the title of "The Chemical Essays of C. W. Scheele."

On the 21st of May, 1886, the one-hundredth anniversary of Scheele's death, the people of Köping held an imposing celebration in memory of the man who had distinguished their town by making it the chosen home of one of the founders of the modern science of chemistry; and the representatives of science in Sweden, Germany, France, Switzerland, and other countries, expressed their sympathy in the occasion in appropriate messages.

CORRESPONDENCE.

MEDIÆVAL JEWISH SCIENCE.

Editor Popular Science Monthly:

SIR: President White, in "New Battles of Science," shows up the reactionary influence of the Christian writers in the middle ages on the knowledge of Nature, beginning with Cosmas Indicopleustes and ending with Albertus Magnus—their denial of the earth's spherical shape, their bringing rain from beyond the firmament, etc., all on the strength of Scripture. Now, I am proud to say that my brethren, the Jewish scholars of the middle ages, did nothing to push science backward, but took it up cheerfully where the Greeks had left it. The two leading philosophic works of middle-age Judaism, both written in Southern Spain, and in the Arabic tongue, are the "Moreh Nebochim" ("Teacher of the Perplexed") of Maimonides, strongly rationalizing, and therefore ill received by many, and the "Cozari" (feigned conversations with a "Chazar," khan, converted to Judaism), of the great Jewish hymn-writer, Jehuda Hallevi, published in A. D. 1140, thoroughly orthodox. He rejects the metaphysics of Aristotle and of Epicurus, but recognizes what Greece has achieved in physics. Speaking of the Sabbath (Part II, § 20), he assumes for the three Eastern Continents an extent of twelve hours, or 180° in longitude, and a like extent for the ocean, which Columbus had not yet parted in two; he puts Jerusalem midway between *Tsin* (China) and westernmost Africa, and tells us that when the Sabbath begins there on Friday evening at six it is midnight in China, and still Friday noon in the extreme West. Not exact, according to our lights, but up to all the light of his own time. Elsewhere he boasts of the astronomic learning of Rabbi Samuel, an early Talmudic writer, and shows that he and his friends studied the stars only for the purposes of the calendar, new moons, and equinoxes, not with any view to horoscopes. He states with pride that, in the rules for killing and examining beasts for food, the Talmud shows more knowledge of the anatomy of the lungs than can be found in Galen. He also claims that long experience had proved the Jewish measurement of the synodic month and tropical year to be more correct than the numbers given by Ptolemy. He finds no occasion to speak of the origins of rains and thunder-storms; but the absurd notion that rain comes from beyond the firmament could never occur to any of the Old Testament writers, who lived on the narrow strip between the Great Sea and the Syrian Desert, and got their rain with the west wind and their dry heat with the dreaded east wind (*kadim*), nor to any one who read their books in the Hebrew text. The "Cozari" proves that in the darkest ages our race kept its mind unclouded.

The opinion that thunder-storms are the work of the devil or of evil spirits could not grow up among a people who were taught from their childhood to greet lightnings or falling-stars with the benediction, "Blessed be thou, O Lord, who doth the work of creation!" and to welcome thunder with the kindred formula, "Blessed be thou, O Lord, of whose strength and of whose might the world is full!" Respectfully,

LEWIS N. DEMBITZ.

LOUISVILLE, KENTUCKY, *July* 24, 1887.

HATS AND BALDNESS.

Editor Popular Science Monthly:

SIR: A few months ago you published in the pages of the "Monthly" an article on hats as a cause of baldness, which has been extensively quoted and has attracted much attention. I have delayed writing to you on the subject until I had leisure to look up an article written by my father, the late Dr. Austin Flint, nearly thirty-five years ago. I send an extract from this article which appeared as an editorial in the "Buffalo Medical Journal," March, 1853, No. 10, page 651, and was entitled "Hats and Baldness": " . . . The most characteristic trait of the hat is the tightness with which it encircles the head. Herein consists, in our opinion, its agency in the loss of hair. The stove-pipe hat must needs encircle the head tightly, in order to be secure in its position in spite of wind and other disturbing forces. To appreciate the degree of compression, one has only to note the indentation on the forehead after a tightly-fitting hat has been worn for some time. Everybody knows how commonly this is to be observed. The head is, in fact, pretty firmly ligated while the hat is worn. Now, what must be the effect of this on the circulation? Plainly, the effect is to interrupt the circulation in the scalp above the circle on which the compression is made. It is precisely like tying a cord around the head, sufficiently to diminish, if not stop, for the time, the flow of blood through the temporal and other ar-

teries by which the blood is distributed to the superior portion of the scalp. The hair-follicles, as is well known, are very vascular. Their functions require this vascularity, and an adequate, constant supply of oxygenated blood. If this supply be diminished, the growth and nutrition of the hairs are proportionally affected; and, finally, the *pulp* inclosed in the follicle withers and dies, as does any other part when deprived of the *pabulum vitæ*. This effect occurs on the crown, because interruption of the circulation in arteries is always felt most in the parts to which the terminal branches are distributed.

"Such is our explanation of the fact that baldness is so frequently observed in the young and middle-aged men of the present generation. The remedy is to repudiate the present fashion of hats. Let some inventive genius devise a substitute for the unseemly, as well as hair-destructive, article which is now the *mode*, and we are firmly convinced that toupees will become objects of curiosity rather than utility, and the bald pate will again be venerated as the distinguishing trait of old age." . . .

AUSTIN FLINT, M. D.

No. 14 WEST THIRTY-THIRD STREET,
NEW YORK CITY, *August* 25, 1887.

THE MEANING OF EDUCATION.

Editor Popular Science Monthly:

SIR: In an article on "Modern Over-Education" in the July number of "The Popular Science Monthly," taken from "Land and Water," the writer says, "The Latin word *educo*, from which our English word is derived, means simply to draw out or to train."

It will be remembered that there are two words in the Latin, spelled alike, but with somewhat different meaning: the one *ēdūco, educere*, meaning "to lead forth," "to draw out," etc., from which we get *educe* and *eduction;* the other, *ēdŭco, educare*, meaning "*to bring up* a child physically or mentally," "to rear," "to educate," also "to nourish," "support," etc. It is from the latter, of course, that we get our word "education," from which it will appear that the idea originally conveyed by it was not simply that of *leading* or *drawing forth*, but of *rearing, nourishing*, and the like. It seems to me well to bear in mind that the educator must see to it that the minds placed under his care need nourishment, as well as the drawing forth or training of the faculties, if they are to be properly developed and strengthened. In other words, there must be *wholesome food* for mind as well as for body, besides the necessary exercise or gymnastics.

Mere exercitation, independently of what is presented to the attention, can scarcely be expected to accomplish the best results.

I have ventured to send you this note because I have reason to believe that quite a number mistake the true etymology of our word "education," and that there is something to be gained by a proper consideration of its true origin.

Very respectfully yours,

L. L. HOLLADAY.

HAMPDEN SIDNEY, VIRGINIA, *July* 9, 1887.

AN EXPLANATION.

Editor Popular Science Monthly:

SIR:. I had not intended to reply to any further communication of Miss Gardener's, but as in her letter, published in your September issue, she accuses me of a willful deception, it seems necessary that I should again address you.

In my paper on "Brain-Forcing in Childhood" I stated that the human head does not grow after the seventh year, and that the hat that is worn at that age can be worn just as well at thirty. For this statement Miss Gardener, in her first communication, called me to an account, and I in my answer admitted, as I thought frankly, that I had made a mistake, and that I should have said *brain* instead of *head*. She now, in her last letter, endeavors to make it appear that I had asserted that, by a slip of the pen or by some other inadvertence, I had said *head* when I meant *brain*.

My language admits of no such interpretation except from one anxious to misinterpret. I made a mistake. I thought the fact was as I had stated it, and when I found out my error, and that it is the brain and not the head that does not grow after the age of seven, I made the proper correction. In all the points necessary to my argument I was right, for the hair, skin, muscles, etc., of the head can not be regarded, even by Miss Gardener, as contributing to intelligence.

Miss Gardener's attack is a quibble altogether unworthy of her. She might properly have censured me for my thoughtlessness or ignorance, but that is all. I have never been ashamed to confess my mistakes, and to allow my adversaries to get whatever comfort from them they can extract, and she is welcome to make the most of my error in this matter.

As to the point in question, it is scarcely to be supposed that, knowing that Miss Gardener was in possession of my whole statement, I should have endeavored to deceive either her or the public in the matter.

WILLIAM A. HAMMOND.

[Want of space compels the termination of this correspondence with the present letter.—EDITOR.]

EDITOR'S TABLE.

ENCROACHMENTS OF THE STATE.

THE article by Dr. Shaw, in a recent number of the "Contemporary Review," on "The American State and the American Man," has started inquiry as to the extent to which individual liberty is being encroached upon in this country by the extension of State functions. The result has been to show that, in most of the States of the Union, a rapid process is taking place of transference to the government of functions and responsibilities heretofore devolving on the private citizen. It would almost seem as if people had found a new toy—the power of legislative action—and were playing with it with a kind of greedy zest. According to the accounts furnished, there is a perfect rain, not to say deluge, of statutory regulations on every conceivable subject proceeding from our State Legislatures. Acts of incorporation are granted to every body of persons who come forward and claim that it would be a public benefit if they were granted the powers and privileges of a corporation, and intrusted with the control of some particular art or profession. The general result of this legislative activity is that free competition is suppressed, and individuals are released to a large extent from all responsibility of choice as to how or through whom they shall get this thing or that thing done. The State legalizes certain schools of medicine and refuses to legalize others. It makes the taking out of its certificates obligatory on all who would engage in the profession of teaching. It provides for the inspection and stamping of various articles of merchandise. It seeks, as far as possible, apparently, to reduce the life of each individual citizen to a kind of safe mechanical routine. So soon, indeed, as a burden of responsibility begins to be felt in any quarter, some busy law-maker, moved by some interested party, offers to lighten the load by a special act of legislation. What should not be lost sight of is, that there is always somebody who stands ready to make money out of each new law inscribed on the statute-book. Back of the whole body of oleomargarine legislation stands the farmer who does not want his butter-trade subjected to a trying competition. And so with all special laws of a protective kind. We hear of a demand made in one quarter for the incorporation of the music-teaching profession, so that henceforth no one may venture to inculcate the elements of music save in accordance with the views and theories of the incorporators. Of course, these public-spirited ladies and gentlemen, who are so anxious to protect the community from the injury which might be inflicted by ill-prepared music-teachers, have their own interests to serve in the business. Competition will be restricted, and all who want to teach will have to pass through the probation which it may please the incorporators to prescribe. People who want to earn an honest living by imparting the little they know will find their pathway blocked by a special law passed in the interest of the magnates of the profession.

Dr. Shaw, in the article above referred to, says that there is no use in trying to draw a distinction between functions that the State may properly undertake and those which it should abstain from assuming. The sooner, he holds, we come down to the position that every thing is a lawful subject of State interference, and that the question is never

more than one of expediency, the better it will be in every respect. We can not view the matter in the same light. We are quite prepared to apply the test of expediency; but we hold that, if it can be shown that there is a large class of subjects which it is not expedient for the State to touch, then it may be said that there is ground which it is not lawful for the State to enter. In applying the test of expediency, however, we would apply it in the broadest sense. We should be careful not to mistake a good intention for a good tendency; nor should we ever consent to overlook the probable effect of any given law upon the character of the community. We should claim to judge it not by its immediate and direct effects only, but by its remote and indirect ones as well, ever keeping in view the principle that the well-being of the community must in the last resort depend on the personal qualities of the men and women composing it. Let others aim, if they will, at the protection of everybody against everything, and the reducing to a minimum the energy, caution, judgment, and courage required for the conduct of life; we shall join in no such crusade. We believe that society possesses, and that individuals possess, powers of adaptation to varying contingencies which the protective spirit in contemporary legislation is greatly tending to obscure and overlay. We want to see individual character more and more brought into prominence as a condition of success, and public opinion developed and educated into a force that can act for good independently of legislative support. As things are going at present, it looks as if the "coming slavery," foretold by a great philosopher, might be hastened beyond the measure of his fears. It behooves all who believe in individual liberty and individual responsibility as conditions of social well-being to raise their voices against a tendency which certainly is hostile to both.

THE AMERICAN ASSOCIATION.

THE thirty-sixth meeting of the American Association for the Advancement of Science, which was held in this city in August, was well attended, and made a good record of work. While it was not marked by any papers of unusual brilliancy, or by the announcement of any discoveries or theories of startling import, the papers presented, as a rule, bore evidence of careful, intelligent thought, and had their justification either in embodying discussions of public interest and utility, or as being real contributions to some department of scientific research. That the proportion of papers in which the public is interested was liberal, is shown by the fact that while the daily press selected these for notice, carefully excluding all that was technical, they gave fairly full reports, and such as would be likely to impress their readers that the Association was earnestly engaged in the consideration of living questions. Yet, besides these subjects, the daily programmes of the meeting were laden with topics and investigations in pure science, to which the sections equally gave attention.

The address of retiring President Morse, which we publish, takes up the question of what American zoölogists have done for evolution at the point where the author had left it in his address before the Biological Section of the Association in 1876, and brings it down to the present date. In the sectional vice-presidential addresses, Dr. Brinton reviewed the data for the study of the prehistoric chronology of North America; Professor Alvord, in the Economic Section, talked of the way in which we are wasting the substance of our land in our agricultural exports; Professor Gilbert reviewed the work of the "International Congress of Geologists," which, it appears, is the fruit of a suggestion made at the American Association in 1876; and Professor W. A. Anthony spoke of the

importance of teaching physics in the public schools.

The greatest interest was centered in the Economic Section, where a full day was given to the hearing and discussion of the two papers by Professor Atwater, on "The Physiological and Pecuniary Economy of Food," and "The Food of Workingmen and its Relation to the Work done"; and where, at other sessions, President C. M. Woodward, speaking from what had been accomplished under his own supervision, as well as with reference to its practical bearing; and Professor James, looking largely to the future and to the economical side, presented the advantages of manual training in the public schools.

In the Engineering and Mechanical Section, Mr. Edison, by proxy, explained his new pyro-magnetic dynamo, or machine for producing electricity directly from fuel; and Mr. P. H. Dudley described his method for the mechanical inspection of railroad-tracks, by which the slightest flaw or unevenness is detected at once and automatically marked. Professor Ries's method of securing the adhesion of locomotives to railway tracks by the application of electricity, and thus adding to their tractive force without increasing their weight, promises to be of value if it is made practicable.

A joint meeting of the Engineering and Economical Sections was held for the consideration of plans for inter-oceanic communication, at which the merits of the Nicaragua Canal scheme were presented in full. A variety of topics of interest were considered in the Anthropological and Biological Sections; and the transactions of the Physical and Chemical Sections were of interest chiefly to persons engaged in those lines of research.

The Association asked, by resolution, for a reduction of the tariff on scientific books; advised the provision, by act of Congress, of a Bureau of Standards of Measurement for Electricity, Heat, Light, etc.; requested the President to appoint as permanent Superintendent of the Geodetic Survey a man of scientific attainments and trained in that branch; recommended the publication of an index to the publications of the Signal Service; and appointed two committees to secure measures for the preservation of mounds and relics of ethnological and archæological interest—one, to consult with the national authorities respecting relics situated on public lands; the other, with the powers of the States with reference to those within their several territories.

LITERARY NOTICES.

THE MARGIN OF PROFITS. By EDWARD ATKINSON. New York: Putnams. 1887. Price, $1.

THIS work consists of a lecture delivered before the Central Labor Lyceum of Boston, in May last, together with a reply made at the time by Mr. E. M. Chamberlin, and Mr. Atkinson's rejoinder. The object of the lecture was to show that the capitalist is the friend and not the enemy of the laborer, whatever disagreement there may at times be between them. Mr. Atkinson first draws attention to the fact that the margin of profit—that is, the share of the capitalist in the product of industry—is by no means so large as workingmen are apt to suppose. To prove this, he cites the example of the cotton industry, with which he is perfectly familiar, and gives a statement of the entire cost of production, from the raising of the cotton to the completion of the cloth, showing how much is paid out at each step of the process for labor on the one hand and for capital on the other. He illustrates his analysis of the industry by a chart, and gives the following as the result of the examination:

"When you buy forty yards of cotton cloth at two dollars and fifty cents, you pay the owner of the mill fifteen cents profit, but you also pay about fifteen cents more to other people for profit—that is, thirty cents profit in all; and you pay two dollars and twenty cents directly for labor" (p. 28).

It thus appears that in the cotton business the share of the capitalist is only one eighth of the product, while labor gets the other seven eighths; and, according to Mr. Atkinson, there is no other industry in which the capital is so large in proportion to the product as in this.

The author then proceeds to show that the great improvements in the production that have been made in recent times with the consequent increase of capital, though benefiting the capitalist largely, have benefited the laborer still more. He remarks that in his judgment "there has never been a period in the history of the world in which there have been so many important new inventions or so many applications of previous inventions, all tending to human welfare, as in the last twenty-five years" (p. 109). He adds that during this period, "while prices of the necessaries of life have diminished and while the cost of production has been reduced, the wages or earnings of labor, subject to temporary fluctuations, have been steadily increased." And he concludes that "we are not far away from a period when, either with or without legislation, but, as I myself believe, in spite of meddlesome legislation, the arduous struggle for life will be greatly relieved, both in the time which it will be necessary to give and in the intensity of the work which it will be necessary to apply thereto" (pp. 110, 111). In evidence of these statements he cites a number of statistics showing how great has been the fall in prices in many branches of industry since 1860, while the wages of labor have largely increased.

Mr. Atkinson is strongly opposed to the eight-hour law, holding that the hours of labor can not be permanently reduced except by improvements in production; and this is one of the principal points at issue between himself and Mr. Chamberlin. The latter gentleman, however, in his reply to Mr. Atkinson, takes the ground which many other labor-champions do, that capital and labor are natural enemies; that labor, meaning manual labor, is the sole creator of wealth; with other views of like character and as little foundation. His argument for the laborer's cause is, indeed, far from being a strong one, and his opponent has little difficulty in answering it.

Mr. Atkinson's views are given in a plain colloquial style, but often very apt and expressive. He quotes from Emerson the saying that "mankind is as lazy as it dares to be," and tells his hearers and readers that efficiency in work and economy in expenditure are the only means of acquiring wealth and improving one's condition. He estimates that the American people waste on an average five cents a day for each person, which amounts to a thousand million dollars a year for the whole nation. He affirms that the capitalist is the laborer's friend, not his enemy; and that the prosperity of each is necessary to that of the other. He declares it to be "a great blunder to say that, while the rich are growing richer, the poor are growing poorer; it is only the poor who can't work well or who won't work well, who grow poor while the rich are growing rich in this country." And he adds that "there are two things very much needed in these days: first, for rich men to find out how poor men live; second, for poor men to know how rich men work" (p. 47). Mr. Atkinson's work, if read by those to whom it is specially addressed, can not fail to be useful; and it is to be wished that we had more books of a similar character.

ABUSE OF ALCOHOLICS BY THE HEALTHY. By STANFORD E. CHAILLÉ, of Tulane University, Louisiana. Pp. 36.

IN this paper, which is a part of the transactions of the American Public Health Association, is given one of the most temperate, candid, and useful estimates of the effects of alcoholic drinks on the system that we remember to have seen. A brief review of the history of the use of spirituous liquors satisfies the author that we have no reason to be discouraged respecting the progress of temperance principles and practice; for it "renders it obvious that for many centuries our forefathers have imbued their descendants with faith in the health-giving virtues of alcoholic indulgence. Who can expect the results of such long-continued convictions and customs to be eradicated easily or promptly, and what wonder is it that men continue to credit alcoholics with many virtues that they do not possess?" With regard to the physiological action of alcohol—"Repeated experiments on robust,

healthy men have proved that not even the strongest of these can exceed in a day more than two ounces—that is, only four tablespoonfuls—without diminishing their capacity for work. . . . Whoever does not die before his time, and yet habitually drinks more than two ounces of alcohol daily, will very surely have to pay for it in pains far harder to bear than those inflicted by payment in cash." The almost certainty that those who indulge in even this quantity will demand more, is the universal temperance argument. The complaint of those who apprehend that drunkenness is increasing is answered by citations, century by century, which show that as a whole the present is decidedly the most temperate age in history. As to remedies for the evils of drunkenness, the author has much faith in prohibition, and believes that local option is as nearly sovereign as we are likely to attain.

TEN GREAT EVENTS IN HISTORY. Compiled and arranged by JAMES JOHONNOT. New York: D. Appleton & Co. 1887. Price, 63 cents.

THIS book is intended for young readers; and its object is not merely to teach history, but also to cultivate certain noble sentiments, such as patriotism and love of liberty. The author holds that "patriotism, or love of country, is one of the tests of nobility of character," and adds that "from the earliest times the sentiment of patriotism has been aroused in the hearts of men by the narrative of heroic deeds, inspired by love of country and love of liberty. This truth furnishes the key to the arrangement and method of the present work" (preface). The historical examples which the author has chosen are, in the main, well adapted to his purpose. Some of them, however, can hardly be called struggles for liberty, however interesting and important in other respects, such, for instance, as the Crusades and the conquest of India. The Crusades especially, though having an interest of their own, and, constituting, in one sense, a great historical event, are chiefly memorable as a stupendous example of superstition and folly.

The most interesting portions of Mr. Johonnot's book are those describing struggles for liberty in modern Europe and in our own country. Of ancient events only one is treated—the victorious contest of the Greeks against the Persians. Coming down to modern times, considerable space is given to the struggles of the Swiss with the Austrians and with Charles of Burgundy; to the defense of Scotland by Bruce and his men; and to the gallant and successful fight of the Dutch and the English with the mighty power of Spain. An account is given of the discovery of America, and of the settlement of the Pilgrim Fathers, and the work is fitly closed by a brief sketch of some of the chief battles of the Revolution.

The work is, as the author states on the title-page, a compilation, and some parts of it are quoted directly from other writers. Some of the authors quoted from are inferior in style to Mr. Johonnot himself, which makes one wish that he had written the whole work with his own pen. The book will doubtless find a place for itself and fill it usefully, notwithstanding the many rivals with which it will have to contend.

INDIANA: DEPARTMENT OF GEOLOGY AND NATURAL HISTORY. Fifteenth Annual Report. By MAURICE THOMPSON, State Geologist. Indianapolis. Pp. 359.

THIS is one of the most comprehensive and compact reports of the whole series. Besides presenting the record of the special work done during the year by the department, Mr. Thompson has sought, in a "Compendium of Geology and Mineralogy," by which this is preceded, to give an outline sketch of all that has been discovered and reported upon by his own corps and by his predecessors in office, so that the volume might, in a certain degree, place the student, who can not get the earlier reports, in a situation fairly to understand the geology of the State. In doing this, he has made a treatise that is readable throughout as well as scientifically acceptable. It is claimed that the work of the department, as a whole, has done more than all other agencies combined to advertise the coal, clay, iron, and building-stone of Indiana, and to direct attention to the peculiar advantages offered by their situation and quality. The reports of the former incumbents of the office, though long since exhausted, are

still sought for by intelligent inquirers all over the world; and the present chief of the department has found the answering of letters from outside the limits of the State, as well as within them, touching the results of the surveys, no unimportant part of his official duties. Mr. Thompson's "Compendium" includes sketches of the several geological formations, in their order, which are exposed in the State, from the Hudson River Group to the Coal-measures; an account of the building-stones, of which the oölitic limestone of the Sub-carboniferous is considered the best in the world; and descriptions of the clays, chalk-beds, glacial deposits, and terminal moraine which "passes into Illinois from Warren and Benton Counties, and into Ohio from Randolph and Wayne Counties," and may be seen in section in railroad-cuttings just south of Lafayette. Attention is called in a special study by S. S. Sorby to the *Wabash Arch*, a line of disturbance whose general direction is indicated by its name, which, it is believed, may have some connection with the occurrence of natural gas. A paper on the "Origin of the Indiana Flora," considered with reference to localities as well as in general, is contributed by Professor Coulter and Harvey Thompson; Mr. Thompson describes the Post-Pliocene mammals and the developments of natural gas; and Mr. Sorby gives a study of the prehistoric race of the State. The report of the year's special work includes the surveys of thirteen counties or parts of counties in the central and northern central parts of Indiana.

HOME SANITATION. By the Sanitary Science Club of the Association of Collegiate Alumnæ. Boston: Ticknor & Co. Pp. 80.

THE club which avows the responsibility for this book was organized in November, 1883, for the study of home sanitation. It found, after two years of devotion to this purpose, that the expenditure of time and effort had been "amply repaid by positive and satisfactory results"; and that it had a store of information, derived from the experiences and observations of its members, worthy to be given to the public. This information is embodied, in the form of preliminary statement and questions, in short chapters on the "Situation of the House and Care of the Cellar," "Drainage and Plumbing," "Ventilation," "Heating," "Lighting," "Furnishing," "Clothing," "Food and Drink," and "Sanitary Work for Women." The important part of the text is in the questions, which suggest more than they express or than is conveyed in the statement above them, and "are so framed that an affirmative answer implies a satisfactory arrangement, and also suggest a remedy if the answer is negative." They have been practically tested by the members of the club in their own homes and by other housekeepers, and have been adopted as the basis of a course in sanitary science offered by the Society to Encourage Studies at Home.

GEOLOGICAL SURVEY OF NEW JERSEY. Annual Report of the State Geologist for the Year 1886. By GEORGE H. COOK, State Geologist. Trenton: The John L. Murphy Publishing Company. Pp. 254.

THE report, which simply records the work done during the year, is arranged under the four heads of "Geographic Surveys," "Geological Surveys," "Economic Geology," and "Miscellaneous Items." The work of the geodetic and topographic surveys, though it has all been under the direction of the State Geologist, has been done at the expense chiefly of the United States Coast and Geodetic and Geological Surveys. The work has been going on for twelve years, and will require two years more for completion. Under it the latitude and longitude have been precisely determined for four hundred and fifty-two points, which stand at an average distance of about twenty-five miles apart. The topographic survey has been rapidly advanced, and has been carried over a larger area than in any previous year, and now covers eighteen hundred and ninety-seven square miles. The results are to be recorded in engraved maps on a scale of one inch to a mile, of which there will be seventeen, twenty-seven by thirty-four inches in size. The contour-lines are drawn on these maps so as to show every change of twenty feet in elevation in the hilly portions of the State, and of ten feet in the more level portions. Another important work in this department has been the fixing of bench-marks for the accurate determination of elevations, which,

besides being capable of practical use in many ways, will be serviceable in the future for the detection and measurement of whatever changes of levels may take place. The tides have been made subjects of observation, and show peculiarities, particularly in the bays, which indicate that much is yet to be learned about them. The department of "Geological Surveys" is largely occupied by a close study, by Dr. N. L. Britton, of the "Archæan or Primitive Rocks of Northern New Jersey," illustrated by sections and colored maps, and of their minerals. The "Palæozoic Rocks of the Green Pond Mountain Range" are described by Mr. F. J. H. Merrill; the theory of the Triassic rocks receives further discussion; and the "Yellow Gravel" of the region south of the terminal moraine is the subject of a special report. The department of "Economic Geology" includes the reports of the mines and a republication to meet frequent calls for information, of a special report made in 1876, on the greensand marls. An account is given of the successful drainage of the Great Meadows on the Pequest, in Warren County, and their conversion into excellent farming-lands; and a strong presentment is made of the necessity of draining the meadows of the upper Passaic.

FOURTH ANNUAL REPORT OF THE BUREAU OF ETHNOLOGY TO THE DIRECTOR OF THE SMITHSONIAN INSTITUTION. J. W. POWELL, Director. Washington: Government Printing-Office. Pp. 532.

THE work of the Bureau has been prosecuted on the plan of employing scholars trained in the special researches contemplated, to conduct the necessary investigations and present results for publication. Attention has also been given to promoting and guiding research on the part of collaborators not officially connected with the Bureau, and results of value have been gained in this way. The principal researches mentioned in the present report are mound explorations in West Tennessee and Arkansas, under the direction of Dr. Cyrus Thomas; explorations of cave and cliff dwellings in the cañons of New Mexico and Arizona; Mr. Cushing's Zuñi researches; Mr. Victor Mindeleff's researches among the Moki; photographs of aboriginal ruins, by Mr. J. K. Hillers; work in linguistics, by Mr. J. O. Dorsey; Mrs. E. A. Smith, Dr. J. W. Hoffmann, and Dr. Washington Matthews; and the compilation, in the office, of papers embodying the collected results of field-work, in which many of the correspondents of the Bureau have participated. Several of these papers are given as "accompanying papers" to the report. They are an elaborate treatise on "Pictographs of the North American Indians," by Garrick Mallory, which is profusely illustrated; "Pottery of the Ancient Pueblos," "The Ancient Pottery of the Mississippi Valley," "Origin and Development of Form and Ornament in Ceramic Art," all by William H. Holmes; and "A Study of Pueblo Pottery as Illustrative of Zuñi Culture-Growth," by F. H. Cushing. The illustrations to the whole volume include eighty-three full-page plates and five hundred and sixty-five figures in the text.

PROCEEDINGS OF THE AMERICAN SOCIETY OF MICROSCOPISTS. Ninth Annual Meeting. Chautauqua, New York, August 10 to 13, 1886. D. S. KELLICOTT, Secretary. Buffalo, New York. Pp. 243.

THIS volume contains, besides the accounts of the sessions, reports, and other matters of regular recurrence, twenty-four papers on subjects connected with microscopic science and manipulation. Among the papers of more general interest are the annual address of the president, Thomas J. Burrill, on "Bacteria and Disease"; Mr. R. H. Ward's "Remarks on Making Microscopical Societies Successful," which are of interest to every one concerned in such societies or contemplating the formation of one; Professor H. A. Weber's "Microscopical Examination of Butter and its Adulterations"; Mr. Ernst Gundlach's "Optical Errors and Human Mistakes"; and Mr. Charles E. West's relation of his "Forty Years' Acquaintance with the Microscope and Microscopists."

ANNUAL REPORT OF THE BOARD OF REGENTS OF THE SMITHSONIAN INSTITUTION TO JULY, 1885. Part I. Washington: Government Printing-Office. Pp. 996.

UNDER the operation of an act of Congress permitting the printing of the Smithsonian reports, like those of the heads of departments, previous to presentation to

the two Houses, this volume appears earlier than has been usual. It also covers a shorter length of time, or only half of the year. The report reviews the progress of work in all the departments of the Institution; the explorations in which it has been interested, in all parts of North America, with researches in the remains of prehistoric man in parts of France; publications, including Dr. Rau's "Prehistoric Fishing in Europe and North America"; Vols. XXIV and XXV of the "Smithsonian Contributions to Knowledge"; the "Smithsonian Miscellaneous Collections," in which are included several monographs; the scientific writings of Professor Joseph Henry; the "Report on the Reptiles and Batrachians of North America"; the "Bulletin," and "Proceedings" of the National Museum; and the publications of the National Museum. Information is given concerning international exchanges, and lists of some four thousand foreign correspondents and of the institutions in the United States to which the Smithsonian publications are sent. In the "Appendix" are found the record of scientific progress in 1885, in the several departments of research; various papers relating to anthropology; an "Index to the Literature of Uranium," by H. Carrington Bolton; and a priced list of Smithsonian publications.

WILLEM USSELINSK, FOUNDER OF THE DUTCH AND SWEDISH WEST INDIA COMPANIES. By J. FRANKLIN JAMESON. New York: G. P. Putnam's Sons. Pp. 234, paper. Price, $1.

THIS memoir is one of the papers of the American Historical Association (Vol. II, No. 3). It is devoted to one of that class of promoters of American settlement to whom the author thinks that less than full justice has been given—"of those who, without themselves having come to this country, or shared in the picturesque adventures of the age of settlement, stood behind all efforts toward colonization, and assisted them in ways more prosaic, but not less efficient, nor less deserving of grateful remembrance—the class of colonial projectors. . . . It is the object of the present essay to relate in sufficient detail to enable its importance to be correctly estimated, the career of a member of this latter class, a man almost unknown to the English-reading public, yet who was, though not directly the founder, at any rate the originator of two of our colonies—that upon the Hudson, and that upon the Delaware." In another place Usselinsk is styled "the Lesseps of the seventeenth century." The materials for the biography have been derived from the books and pamphlets of Usselinsk, his manuscripts, and manuscripts concerning him. The abundance and scope of these sources are illustrated by the copious bibliography which is affixed to the end of the work.

VOICE, SONG, AND SPEECH. By LENOX BROWNE and EMIL BEHNKE. New York: G. P. Putnam's Sons. Pp. 248.

THIS is the seventh edition of a work to the merits of which we have already called attention in a notice of a previous edition in the "Monthly" for July, 1884. It owes its origin to the fact that each of the authors —one a surgeon, and the other a teacher —having contributed to the literature of the human voice, both found their views one-sided and needing to be complemented from the experience of the other. They therefore joined to produce a single comprehensive work. In the present edition, as well as in the sixth, the substitution of engravings for the expensive photographs of the larynx and soft palate has made possible a very considerable reduction in price from that of the earlier editions.

LOCAL GOVERNMENT IN CANADA. By JOHN GEORGE BOURINOT. Baltimore: N. Murray. Pp. 72. Price, 50 cents.

THIS is an historical study in the series of Johns Hopkins University. The author, by the public positions he has held, and by the preparation of an account of the "Origin and Growth of Parliamentary Institutions in the Dominion," has enjoyed excellent opportunities for qualifying himself for this special research. His attention was drawn to the subject through the interest awakened by reading the histories of local government in various of our own States, which have appeared in this series. He was convinced that a similar paper on local government in Canada would be of value to students of political science. The

political history of the Dominion is divided, for the purposes of the study, into three important epochs: The era of the French *régime*, from 1608 to 1760; the period of slow growth and accruing experience in the working of representative institutions under British rule, 1760 to 1840; and the period of enlarged political liberties and responsible government, 1840 to 1867. "Since 1867, the various provinces, united as the Dominion of Canada, have entered on a fourth era, pregnant with promise."

BULLETIN OF THE SCIENTIFIC ASSOCIATION. Peoria, Illinois. 1887. WILLIAM H. PARK, Recording Secretary. Pp. 92.

ACCORDING to the historical address of Dr. J. T. Stewart, the Association was organized in 1875, as a summer school for the study of the natural sciences, at which Professors Wood, Hyatt, Wilder, and Comstock lectured. Meetings were held monthly, except in summer, for seven years, and afterward weekly. During the period of the society's existence, two hundred and two papers have been read, on a wide range of subjects of scientific interest. The society began with thirteen members, and now has one hundred, while the average attendance upon the meetings has increased from about twelve to one hundred and five. The museum contains more than ten thousand specimens, and the herbarium embraces the entire flora of the Peoria section, "and more," and the records of visitors to the rooms show that interest in the collections is growing fast among the public. Besides a number of papers having a broader scope in discussion, the "Bulletin" contains articles of more special interest on the geology, paleontology, flora, climate, and coleoptera of Peoria and its vicinity, a study of "The Lake as a Microcosm," and a memoir on the "Immigration of Animals and Plants."

THIRD ANNUAL REPORT OF THE COMMISSIONERS OF THE STATE RESERVATION AT NIAGARA. Pp. 37.

THE commissioners report the reservation nearly clear of obstructions, only two of the old buildings yet remaining on the premises, and one of them to be removed shortly. Improvements have been made in many of the appurtenances of the property, for the convenience of visitors and greater security. Plans were in preparation for the restoration of the scenery of the shore and islands. Some of the fruits of the work of the commission are seen in the improved government of the village of Niagara Falls. A company having been formed to build a railroad along the gorge of the river from below the Falls to the Whirlpool, an act has been secured protecting the reservation against intrusion. The commissioners regret that the whole *débris*, slope from the Falls to the Whirlpool has not been included within the reservation. The Falls were visited during the excursion season by 187,781 persons coming in excursion trains, and probably as many in regular trains. The stay of the visitors is "longer than in former years." The latest measurements give the rate of recession along the whole contour of the Horseshoe Fall since 1842 as about two and four tenths feet per year. The recession of the American Fall has been slight. The heights above the level of the water in the river are, American Fall, one hundred and sixty-seven feet; Horseshoe Fall, one hundred and fifty-eight feet. It is estimated that more than one thousand species of flowering plants and ferns are native at the Falls or in their neighborhood.

REPORT OF THE COMMISSIONER OF EDUCATION FOR THE YEAR 1884–'85. By JOHN EATON. Washington: Government Printing-Office. Pp. 848.

THE present (the fifteenth) annual report of Commissioner Eaton is the last of the series prepared by him. The year has afforded abundant evidence of the value attached to the annual reports of the Bureau in the demand for copies at home and abroad; and, in consideration of this fact, the Commissioner emphasizes the need of uniformity in the general plan and nomenclature of State and local reports, as a means of facilitating analysis and comparative study. Attention is called to several particulars in respect to school attendance. The actual attendance is undoubtedly increasing, but improvement in respect to regularity is not so decided as could be wished. "One of the chief hindrances to the progress of our common schools is the multiplicity of school districts and of independent local authorities. . . . Wherever these 'petty school sovereign-

ties' have been abandoned, the schools are flourishing; where they are maintained, the reverse is true. Among hopeful indications for the future of the common schools are the efforts for the improvement of the teaching force and for bringing the rural schools under efficient supervision, and the increase of the local school-tax in sections of the country which have hitherto been negligent of that provision." Brief histories are given in the report of "Governmental Provisions for Education," and of the growth of State and local educational reports. Space is given to the discussion of the methods of colleges, and of the development of the university system, and to the subject of industrial training; and the usual full and detailed information is given concerning the schools in the several States; the different classes of schools for special and the higher instruction; and to the record of educational progress in other countries.

THE LATEST STUDIES ON INDIAN RESERVATIONS. By J. B. HARRISON. Philadelphia: Indian Rights Association. Pp. 232.

THE author, as a representative of the Indian Rights Association, spent six months in 1886 in visiting the schools at Carlisle and Hampton, and the principal Indian reservations. His purpose was to observe whatever was connected with the condition and character of the schools, farming, home-life, and missionary work, and the general and special relations of the Indians to civilization and their progress therein; the character and efficiency of the administration of affairs; and the quality of Indian land and its adaptation to sustain an agricultural population. This book embodies, in terse language, the results of his observations. The first part of it consists of picturesque descriptive notes of what he saw; the second part, of opinions and reflections suggested to him by it.

POETRY AND PHILOSOPHY OF GOETHE. Edited by MARION V. DUDLEY. Chicago: S. C. Griggs & Co. Pp. 300.

THIS book comprises the lectures and *ex-tempore* discussions that were given before the Milwaukee Literary School in August, 1886. They are an "Address of Welcome," by President John Johnston; "Goethe's Wilhelm Meister," by Professor W. T. Harris; "Goethe as a 'Scientist'," by Mr. James MacAlister; "Goethe's Relation to English Literature," by Mr. F. B. Sanborn; "The Divine Comedy and Faust," by Mrs. Caroline K. Sherman; "Mythology of the Second Part of Faust," by Professor D. J. Snider; "The Elective Affinities," by Mrs. M. A. Shorey; and "What is most valuable to us in German Philosophy and Literature," by Professor W. T. Harris. To these are added "Some Birthday Tributes," including essays on "Goethe as a Man," by Professor W. T. Hewitt; and "Goethe as a Writer, Savant, and Citizen," by Mrs. Horace Rublee; a letter by Goethe, poetical tributes, and an analysis of "The Erl-King."

MISCELLANEOUS PAPERS RELATING TO ANTHROPOLOGY. From the Smithsonian Report for 1885. Washington: Government Printing-Office. Pp. 49.

THE first paper in this group—"Observations on Stone-Chipping"—by George Ercol Sellers, gives the results of the author's personal observations and researches regarding a prehistoric art of which little is known, and adds to our knowledge on the subject. The other papers, each also having its own peculiar interest, are on "Copper Implements from Bayfield, Wisconsin," by Colonel Charles Whittlesey; "Ancient Remains in Ohio," by J. P. MacLean; "A Primitive Store-house of the Creek Indians," by Charles C. Jones, Jr.; "Shell-Heaps and Mounds in Florida," by James Shepard; "Ancient Earthworks in China," by Mark Williams; and a "Plan for American Ethnological Investigation," by the late Henry R. Schoolcraft.

THE DOCTORATE ADDRESS DELIVERED AT THE SEMI-CENTENNIAL ANNIVERSARY OF THE UNIVERSITY OF LOUISVILLE, MEDICAL DEPARTMENT. By DAVID W. YANDELL, M. D. Pp. 26.

DR. YANDELL gives a retrospect of the history of the institution, which was founded in 1817, with brief notices of the many distinguished physicians who have filled chairs of instruction in it. Among these were Dr. Benjamin Silliman, Jr., and Dr. J. Lawrence Smith, who also became famous in general science. A view is also given of

the advance that has been made in fifty years in the opportunities for medical instruction. When the university was established, it was the fourth medical school founded west of the Alleghanies. Louisville alone now has as many medical schools, and there are almost as many between the Ohio River and the Pacific Ocean, as the university is years old.

CONTRIBUTIONS TO THE ANATOMY OF GEOCOCCYX CALFIORNIANUS. By R. W. SHUFELDT. Pp. 281, with Four Plates.

GEOCOCCYX is the ground-cuckoo. The author had already published a paper on the genus in 1886. The present memoir, which is based on a specimen obtained in California, may be considered a second installment on the subject. While ornithologists usually place the genera *Geococcyx* and *Coccyzus* in the same sub-family, *Coccyginæ*, the author's examination discloses anatomical characters in his specimen which are essentially different from the corresponding ones as found in the true cuckoos. He therefore proposes for them two sub-families—the *Centropodinæ*, to contain the ground-cuckoos; and the *Cuculinæ* for the true cuckoos; these, with the third sub-family, *Crotophaginæ*, to make up the family *Cuculidæ*, or North American cuckoos.

LIST OF ASTRONOMICAL OBSERVATORIES. By GEORGE H. BOEHMER. Washington: Government Printing-Office. Pp. 16.

THE list simply gives the names of the observatories and the places where they are situated, classified as "American" and "Foreign." The arrangement is alphabetical, by the names of the places.

AMERICAN JURASSIC MAMMALS. By Professor O. C. MARSH. Pp. 20, with Four Plates.

THE author, who is in possession of all the known remains of mammals from the Jurassic in this country, had already published several articles descriptive of them; but a large amount of new material has been secured, including representatives of several hundred individuals, and bones of various parts of the skeleton. The fossils, though fragmentary, are usually well preserved; but, as a rule, no two bones of the skeleton are found together. This fact, with the diminutive size of the animals and other circumstances, makes investigation difficult. The first specimens discovered in this country proved to be very near allies of European forms; later ones resembled others described by Owen, but, as the skeletons were more complete, differences appeared. A few American genera have no known representatives in Europe, while some forms found there are unknown here.

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Willson, F. N., Princeton, N. J. A Completed Nomenclature for the Principal Roulettes. Pp. 15.

Abbott, Helen C. De S., Philadelphia. Plant Analysis as an Applied Science. Pp 35; Plant Chemistry as illustrated in the Production of Sugar from Sorghum. Pp. 16.

Huston, H. A., Director, Lafayette, Ind. The Indiana Signal Service, July, 1887. Pp. 10.

Hay, O. P., Irvington, Ind. A Preliminary Catalogue of the Amphibia of the State of Indiana. Pp. 10. The Amphibians and Reptiles of Indiana. Pp. 23.

Jordan, David S., and Evermann, Barton W. The Food-Fishes of Indiana. Pp. 16.

Parker, Professor H. W., Grinnell, Ia. Fruit and Fruit Culture as related to Health. Pp. 8.

Shufeldt, R. W., M. D. The Skull in the Apaches. Pp. 10.

Weed, Clarence M. Notes on some Illinois Microgasters. Pp. 8.

Godfrey, John, Louisville, Ky. Medicine and Medicine-Men (Poem). Pp 34.

Investigation of the New York City Asylum for the Insane. Report of the State Board of Charities. Pp. 43.

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Crothers, T. D., M. D., Hartford, Conn. The Alcoholic Question Medically considered. Pp. 5. Temperance, Parties, Politics. Pp. 3.

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Vassar Brothers' Institute, Poughkeepsie, New York. Transactions in the Scientific Section. Pp. 282.

Garden City Dairy Company of Chicago. An Abstract of the Oleomargarine Question. Pp. 30.

Turner, J. B., Jacksonville, Ill. Differentiation of Energy as the Basis of Philosophy and Religion. Christ and Creeds. Christ and Creeds contrasted. Pp. about 50.

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Paz, Dr. Campos da. A Questão dos Vinhos (on the Question of Wines). Rio de Janeiro. Pp. 384.

Ph. Pellin. Catalogue Special des Instruments de Météorologie (Special Catalogue of Meteorological Instruments). Paris, France: Rue de l'Odéon, 21. Pp. 32.

Nelson, Dr. Wolfred, of Montreal. Aperçu de quelques Difficultés a vaincre dans la Construction du Canal de Panama (Summary of some of the Difficulties to be overcome in the Construction of the Panama Canal). Paris, France: T. Symonds, 90 Rue Rochechouart. Pp. 71.

POPULAR MISCELLANY.

Economy of Food.—In his American Association paper on "Economy of Food," Professor L. O. Atwater laid down the principle that "the cheapest food is that which furnishes the actually nutritive materials at least cost." The nutriments of vegetable food are, he said, in general much less costly than the animal foods. The animal foods have, however, the advantages of containing larger proportions of protein and of fats, and the protein at least in more digestible forms. Flour, meal, and other staple vegetable foods, furnish the nutriments at only a fraction of their cost in ordinary animal foods. At market prices, current in the Eastern States, the cost of the protein ranges at from eight to thirty-four cents a pound in the staple vegetable foods, and from eighteen cents to somewhat over one dollar a pound in the staple animal foods. In oysters it ranges at from two to three dollars a pound, in salmon sometimes to five dollars a pound, in beef at from ten to twenty-five cents a pound from about forty cents to one dollar and ten cents. In many of the usual food-fishes the nutritive material is dearer than in beef. The less expensive kinds of meat contain as much nutriment as the costlier kind; and the different grades of flour have a much more nearly equal nutritive value than is commonly supposed. Among the vegetable foods, wheat-flour, corn-meal, and other cereal products are in general the cheapest and most economical. Wheat-flour at six dollars a barrel and potatoes at forty cents a bushel would furnish nutritive material at about the same cost. The prices of the choicer food-materials are regulated by flavor as well as by the amount of nutritive material, which in some is hardly a fraction of the price. With exceptions that are easily explained, the prices of foods that are bought and used for their nutriment tend to shape themselves proportionately according to the actual values. Taking the world through, the mass of people select those foods which furnish the actual nutrients at the lowest cost; but there are marked exceptions in the United States, where many, even among those who desire to economize, use needlessly expensive kinds of food. "They too often endeavor to make their diet attractive by paying high prices in the market rather than by skillful cooking and tasteful serving at home." Wastefulness of food shows itself in the purchasing of more than is needed; in using part of the excess to overload the alimentary organs and throwing the rest away; in purchasing food that seems cheap but is really dear; in using costly materials where less expensive ones would serve as well; and in the false economy of using too little of one material and too much of another. Great evils accrue from these practices, in the loss of money and the deterioration of health; and "some of the wisest students of physiology and hygiene are persuaded that improper eating, and especially overeating, is a source of more disease than any other one thing."

Virtues of Mountain Air.—It may be received as proved that mountain air is good in cases of consumption. Why it is so, may be explained by reference to the qualities of the air of great altitudes, among the most conspicuous of which are its purity, its rarefaction, and its coldness. All modern observers, says the "Lancet," are agreed that pure air is the most essential requisite in the treatment of the scourge. Pure air is not to be found near the great centers of human population, nor even in ordinary lowland country. To obtain it in perfection we must look to the ocean, the desert, or to great altitudes. In these three localities we are far removed from the ordinary sources of atmospheric contamination, and it is hardly necessary to seek to assign any precedence among them, as in each case the atmospheric purity is practically absolute. The next and most essential characteristic of the air, at great altitudes, is its rarefaction, by virtue of which it provokes deep and full respirations, thus promoting pulmonary expansion, and affording a favorable condition for the absorption of morbid deposits. It was long believed that rarefied air tended to promote hæmorrhage, and the well-authenticated stories of the sufferings of mountaineers from epistaxis and melæna, seemed to confirm the belief. But it was forgotten, when these stories were brought forward, that the conditions of blood-pressure at the various orifices are different from those which prevail in the internal organs. The congestion at the surface of the body must be accompanied by a proportionate anæmia of the deep-seated parts, and among them of the lungs. Hence, rarefaction of the air, so far from being injurious in cases of pulmonary hæmorrhage, affords a means for its arrest and relief. Cold is now known to be at least not unfavorable in phthisis. The air at great altitudes is not only very cold, but also very dry; and this combination of conditions tends to correct unhealthy secretions, while it is, at the same time, promotive of appetite and physical activity. This point is one of great magnitude.

Clothes-Moths.—Clothes-moths, injurious to woolen goods and furs, are of the species of *Tinea—pellionella, biselliella, tapetzella*, or *rustica*. The most common one is *Tinea pellionella*, which in its mature state carries about half an inch expanse of wings. Its fore-wings are shining, grayish-yellow, with three indistinct brownish spots in the middle, and its hind-wings are whitish-gray. It is abundant in houses, and may be found at any time between January and October, though most abundantly in the early summer months. The moth is innocent. The larva, which does all the damage, is a tiny caterpillar, dull whitish, with a reddish-brown head. It is the only one of the four species that makes a tunic or movable case for itself. This case is very ingeniously constructed, and consists of an outer layer of fragments of the articles it has fed upon, and an inner layer of silk, forming a soft and smooth lining. It is nearly cylindrical in form, but of slightly larger diameter across the middle, and a little flattened above, and it is open at both ends. These cases are varied in their appearance, and of different colors, according to the color of the goods from which they are formed. The case is enlarged as the insect grows, both by adding to its length and to its circumference. For the latter enlargement, the case is split and patched up in two slits at each end, with an ingenuity that borders on intelligence. The chrysalis state is assumed inside of the case, the caterpillar becoming, by throwing off its last larval skin, a little, yellowish-brown, helpless thing, similar in form to the chrysalides of the larger moths. The chrysalis is anchored by fine threads to the cloth in which the insect lives. From this the perfect insect emerges, when its time has been fulfilled, lays its eggs, and then dies. The eggs are extremely minute, and are deposited on the cloth, or in crevices and corners close to a supply of food. The young grubs begin life by attacking the old cases of their progenitors, with which they make cases for themselves, and begin to feed on cloths proper at a later period of life.

Polished Objects of Silicified Wood.—Mr. George F. Kunz, in exhibiting before the American Association polished specimens of jasperized and agatized woods from Arizona, referred to the description of these woods which he had published in the "Monthly" for March, 1886, their magnificent

colors, and their capacity, on account of the large sections which they would afford, to furnish art-objects of unexampled qualities. Although it was thought that sections two or three feet in diameter might be produced, it has until very recently not been possible to get such sections polished. At last machinery was found competent to do the work; and Mr. Kunz was able to show some beautiful large specimens, which had been cut by a gang of seven saws and polished at Sioux Falls, Dakota, by water-power from the falls, on wheels fourteen feet in diameter. The objects exhibited included one column eleven and a quarter inches wide and twenty-one inches high, cut transversely across the tree so that the heart was visible on two sides of it, with the radiations in all directions; also five sections, measuring twenty-five, nineteen and a half, twenty-four, seventeen and a half, and thirteen inches in diameter, respectively, so highly polished that, when turned with the back to the light, they formed a perfect mirror. All of the specimens were brilliant in color.

Telephonic Communication between Ships.—Professor Lucien E. Blake described in the American Association a method which he had conceived in 1883 for making telephonic communication between ships at sea. A sound-producing apparatus was to be attached to each vessel, and to be worked under the surface of the water; and each vessel was also to have a sound-receiving apparatus, to take up the signals from other vessels. Signals, intelligible by means of a code, could be produced by this apparatus, which would be transmitted in all directions through the water with a velocity four or five times that in the air. For steamships the sound-producing apparatus was designed to be a steam fog-horn or whistle, specially constructed to sound under water, and to be heard at least six or eight miles off. With such whistles, a Morse alphabet, of long and short blasts and pauses, was to provide a means of extended communication, while a simple universal code would indicate a ship's course. Since ignorance of the very presence of a ship, rather than incorrect estimates of her course, has been the principal cause of ocean collisions, the simple hearing of the sound would prove a most excellent general safeguard. Bell-buoys were to have a second bell added under water, while lightships, lighthouses, and any headlands might also be provided with submerged bells, which could be rung from the shore when necessary. Sailing-craft would also have bells, which, if like ordinary locomotive-bells, could be heard at least two miles under water. By the method described, in October, 1885, signals were transmitted and received through one and a half mile in the Wabash River from a locomotive-bell, around three or four windings of the stream.

Teaching Physics in the Public Schools.—Professor W. A. Anthony, speaking in the American Association, Section of Physics, on the importance of teaching physical science in the public schools, said that proper scientific instruction in the primary schools would teach children to avoid the mistake of attempting the impossible. While grammar should be put off to the last, language should be taught by reading, not by rules; the geography, after teaching the form of the earth, should be used only as a book of reference; and the commercial departments of arithmetic should be relegated to the business-school; children in their earliest experiences have to do with heat, light, sound, movement, and magnetism. Physics should be taught by calling attention to familiar facts, and then explaining them.

Effect of Light on Bacteria and other Organisms.—Messrs. Downes and Blunt, in two papers read before the Royal Society in 1877 and 1878 on the effect of light on bacteria and other organisms, and on protoplasm, announced the conclusion that light is inimical to these organisms, and under favorable circumstances may wholly prevent their development. The effect was shown to be due to oxidation, which was stimulated by light, and ended in the extinction or in the great depression of the vitality of the organisms submitted to it. The authors furthermore declared that the maximum of the oxidizing effect was near the violet, or in the more refrangible rays, and was comparable with the chemical phenomena of

photography. When we come to the other end of the spectrum, the yellow and red, or more refrangible rays, we find that they promote the formation of chlorophyl and so turn vegetation exposed to them green, favoring the growth of green plants. In this we may discover one of the purposes which chlorophyl fills—as that of a special coloring-matter to the plant to filter out the more injurious rays and protect the delicate protoplasmic cell-contents from their destructive action.

Healthy and Unhealthy Occupations.—The English Registrar-General has made a comparison between healthy and unhealthy occupations. Assuming the normal average death-rate of the community as the unit of comparison, and calling it 1,000, particular occupations may be regarded as healthy or unhealthy according as the death-rates among those pursuing them fall above or below that figure. The most healthy occupation appears to be that of ministers of religion, whose rate is 556. Next are gardeners and nurserymen, 599; farmers and graziers, 631; agricultural laborers, 701; schoolmasters, 719; and grocers, coal-merchants, paper, lace, and hosiery manufacturers, wheelwrights, ship-builders and coal-miners, with all of whom the average death-rate is under 775. The most unhealthy occupations are the trades connected with the liquor-traffic and hotel service, with which the death-rate is 2,205; following these are general laborers in London, 2,020; costermongers, bankers, and street sellers, 1,879; innkeepers, etc., 1,521; and brewers, 1,361. After the trades concerned with alcohol, the highest rates are furnished by occupations that involve the breathing of dust—other than coal-dust—and exposure to lead-poisoning. The death-rate among butchers is also high, 1,170.

Cause of Thunder.—M. Hirn explains thunder and the explosive noise of meteorites by observing that the air traversed by an electric spark—that is, a flash of lightning—is suddenly raised to a very high temperature, and has its volume considerably increased. The column of gas thus suddenly heated and expanded is sometimes several miles long; as the duration of the flash is not even a millionth of a second, it follows that the noise bursts forth at once from the whole column; but for an observer in any given place, it begins when the lightning is at the least distance. In precise terms, the beginning of the thunder-clap gives us the minimum distance of the lightning, and its duration the length of the column. The author points out that a bullet whistles in traversing the air, so that we can to a certain extent follow its flight; the same thing happens with a falling meteorite just before striking the earth. The noise actually heard has been compared to the flight of wild geese, or to the sound produced when one tears linen; it is due to the fact that the air, rapidly pushed on one side in front of the projectile, whether bullet or meteorite, quickly rushes back to fill the gap left in the rear. The velocity of the meteorite is so great that the matter on its surface will be torn away by the violence of the gaseous friction produced, and will be vaporized at the same time by the heat. This is undoubtedly the origin of the smoke which meteorites leave trailing behind them. With this velocity the sound following the meteorite is vastly deeper and more like thunder than that which attends the passage of the relatively slow-going bullet.

Prehistoric Chronology of America.—Dr. D. G. Brinton, Vice-President of the Anthropological Section of the American Association, gave there a "Review of the Data for the Study of the Prehistoric Chronology of America." The resemblances between American legends and Oriental myths were considered accidental. The annals of the Mexicans, the Mayas of Yucatan, and the Quichas of Peru, carry us back hardly more than five hundred years. The recollections of the more savage tribes did not extend back more than two centuries. A calm weighing of the testimony respecting the stone buildings of Mexico, Yucatan, and Peru, places them all well within our own era, and most of them within a few centuries of the discovery. The much more ancient artificial shell-heaps along the coasts furnish data to prove that the land was inhabited several thousand years ago. The industrial activity of man in America may be traced by the remains of his weapons, ornaments, and tools,

made of stone, bone, and shell. Specimens of polished stone and pottery testify to a reasonably-developed skill; but in the Trenton gravels and a few other localities, genuine palæolithic remains have been found, putting man in America at a date coeval with the close of the Glacial epoch, if not earlier. Vast antiquity is further proved by the extensive dissemination of maize and tobacco, and by the existence of about two hundred radically different languages, both of which must have required long periods of time in development. The American race is distinctively a race by itself, and appears so in the oldest crania from the Quaternary.

The Food of American Workmen.—In his American Association paper on "Food of Workingmen and its Relations to Work Done," Professor L. O. Atwater said that statistics of the dietaries of considerable numbers of Americans, mostly of the working-classes, show that their food is ample in amount, and includes large proportions of meat. Chemical examinations of the dietaries showed them to be richer in actual nutritive material and potential energy than even the large quantities would imply. This is because they contain so great proportions of meat and other nitrogenous and fatty substances. Comparing the standard of diet prevailing among the workingmen of Massachusetts with that of Germany, it is shown that laborers in Massachusetts average just about one half more than the German standard requires. It thus appears that the food of the American laboring-man is much more nutritious on the average than that of his European competitors. It is also shown that he turns off much more work than the European workingman. He is better paid, better housed, better clothed, and better fed than the European. He has better opportunities for self-development, more to stimulate his ambition, and more hope of reward if his work is efficient. These factors are all connected, but the explanation of his superior capacity for work is to be found largely in his superior nourishment.

Optimistic and Pessimistic Diseases.—Dr. Charles Porter Hart read a paper in the American Association "On the Correction of Certain Mental and Bodily Conditions in Man," the burden of which was to indicate that diseases located above the diaphragm are optimistic in their tendencies, while those below the diaphragm are pessimistic. His attention was first called to the subject by a patient who, suffering from an abdominal disease which seemed to produce a mental aberration, possessed most decidedly pessimistic views. Upon every subject that could be suggested—social, governmental, or religious—his views were of a markedly gloomy character. According to the table of disease-tendencies which the author has constructed, chest-diseases give buoyancy to the system, abdominal diseases are depressing, and diseases of a constitutional and chronic character, like rheumatism, malaria, and dropsy, are equally pessimistic and optimistic.

The Physical Aspect of Economics.—Mr. P. Geddes, in a British Association paper on "The Physical Aspect of Economics," said that the present isolation of economic from physical and biological studies, in spite of the clear dependence of the social sciences on the preliminary one, was to be accounted for, not on rational but simply on temporary grounds—that of the pressure of detailed labor upon every specialist. Yet, the sciences were needed on every hand. The population question was a strictly biological one. So, too, was that of competition, and even of individualism *versus* socialism, which largely came down to a dispute between the advocates of natural and artificial selection respectively. The popular idea of progress, as lying essentially in the quantity of wealth and in the number of population, needed thorough replacement of the scientific one—that of the improved average individual quality of the organisms composing the society, and of the material surroundings upon which their evolution depended.

The Falls of the Orange River.—Mr. G. A. Farini, who has recently made a journey across the Kalahari Desert in South Africa, succeeded in seeing and photographing the falls of the Orange River, which he was told could not be done. "We had," he says, "to swim rapids, climb rocks, and descend precipices by ropes in order to take the views. The river is broken up into many streams by huge rocks and bowlders, some of them rejoining to form the main

waterfall, and others cutting out separate channels to the great gorge, some four hundred feet deep and sixteen miles long, worn in the solid granite. These streams form many rapids, and, when the river is half full, rise and form over a hundred separate cascades, unsurpassed for beauty and picturesque grandeur. When the river is full, many of them join to make one mighty sheet of water, rivaling the great Niagara, as it pours into the abyss nearly four hundred feet below. At low water, the only time it can be approached, the Hercules Fall is one hundred and sixty-five feet high, with several smaller falls at the sides, which are three hundred and fifty feet high, and are caused by the same water before it reaches the main fall."

NOTES.

PERTINENTLY to an expression of doubt by Mr. David A. Wells in one of his articles on Mexico, as to the Aztecs having knowledge or making use of metal tools, Mr. W. W. Blake, in the "American Antiquarian," mentions as being on exhibition in the Archæological Rooms of the National Museum of Mexico, idols, beads, and engraved clasps of gold; lip-ornaments and other articles of silver; numerous tools, weapons, and ornaments of copper; and "chopping-knives" of copper, which are supposed to have been used as money.

NINE tenths of wild animals in confinement are said by a medical writer to be subject to heart-disease; but all animals have their peculiarities. Elephants are subject to many diseases, the most common and fatal of which is rheumatism. Monkeys and baboons generally die from bronchial affections and heart-disease, and suffer much from typhoid fever. Animals of the feline race are most subject to dysentery and heart-disease; and their prey, deer, antelopes, etc., are most liable to the same afflictions. Animals of the canine tribe are the healthiest, but too many wolves must not be kept together, or they will eat one another.

DR. R. W. SHUFELDT believes that the veterinary staff of our army needs improvement, and has suggested a plan for its reorganization, with a corps of officers carefully chosen. Thus properly organized, it could form an invaluable nucleus on which to build in time of war; in time of peace could do service to science by making comparative studies in diseases and injuries among all the domesticated animals; could more fully develop the morphology and physiology of our mammalian fauna—a work in which there is need for immediate action before some of the types shall become extinct.

IN a paper on "Indicative Plants," Dr. R. W. Raymond considers a connection which is reported to exist between certain plants and the metallic contents of the soil on which they grow. Among the instances cited are the zinc violet (*Viola calaminaria*), of the Calamine Hills of Rhenish Prussia and Belgium; the lead-plant (*Amorpha canescens*), believed by American miners to grow only in localities containing galena; and the silver-plant (*Eriogonum ovalifolium*), which is regarded as a sign of silver-ores. The theories on this subject, if there be any, still lack the essential elements of verification.

GENERAL PRJEVALSKY is to be presented by the Imperial Scientific Society of St. Petersburg with a gold medal which has been specially struck in his honor by order of the emperor. It bears on the obverse the initials of the recipient, and on the reverse the inscription, "To the first student of the natural history of Central Asia."

INDIAN botanists report upon a plant which has the singular property of destroying the taste of sweetness. It is an asclepiad, and is called *Gymnema sylvestre*. After chewing a few of the leaves for a short time, if sugar be taken, the palate is found to have become insensible to all of its peculiar qualities, and it will have no more taste than sand. General Ellis has found that the *Gymnema* has also the property of abolishing the power of enjoying a cigar. It also destroys the bitter taste of quinine; but it does not affect pungent and saline things, astringents, and acids. The peculiar property of the leaves is dissolved out by alcohol, and appears to reside in an acid which is called *gymnemic* acid.

THE Swedish count, M. Björnstjerna, suggested more than forty years ago, in a book on "The Theogony of the Hindoos," that, as both poles must have been cooled to a suitable temperature at the same time, the earth might have been peopled from the north pole with its white races, and from the south pole with its colored races.

OBSERVATIONS made at the late South Kensington Aquarium upon the effect of temperature on fish, show that the dogfish, mullet, conger, skate, flounder, bass, cod, trout, catfish, pike, and carp are extremely hardy, and can exist in a temperature ranging from 34° to 71°. The gurnard, wrasse, bull-head, sole, bream, cray-fish, blennie, perch, dace, tench, minnow, chub, roach, and gudgeon are sensitive to extremes of temperature.

Dr. Orme Masson, of the University of Melbourne, takes a hopeful view of the prospects of chemistry in Australia. The university expects soon to have well-equipped laboratories for the practical instruction of classes of medical students and for the accommodation of specialists.

The military doctors account for the prevalence of diseases of the heart in the French army as arising from the fatiguing duties imposed on recruits, at an age when, generally, the development of the body is not in harmony with that of the heart, but either in advance of it or behind it. In the latter case, there is hypertrophy of growth; in the former, insufficiency.

Mr. Goschen, British Chancellor of the Exchequer, recently assured a deputation of local university colleges that the subject of further developing technical and scientific education would receive the most serious attention of the Government.

Mr. T. P. White, in a communication to the Chemical Society, gives a decidedly negative answer to the question whether the acids of canned fruits may not form poisonous salts with the tin. He reports, as the result of his experiments, that "tin is entirely devoid of danger when taken internally in any form that might arise from being in contact with fruits or vegetables." He believes that the cases of accidental poisoning attributed to tin were due to solder or other impurities—arsenic, copper, or lead. Professor W. Mattieu Williams says that there need be no lead in the solder—that it is only put in for cheapness' sake, and that tin makes a superior solder to any alloy. Therefore, all danger may be obviated by prohibiting the use of any other solder than pure tin.

Professor Chevreul, on the 31st of August, which was his one hundred and second birthday, in perfect health, attended a meeting of the Agricultural Society and made a pleasant speech, thanking his colleagues for a bouquet which they had presented to him.

The President has appointed Professor G. Brown Goode to succeed Professor Baird, deceased, as United States Commissioner of Fish and Fisheries.

OBITUARY NOTES.

Alvan Clark, the famous telescope-maker, died in Cambridge, Massachusetts, August 19th, in the eighty-fourth year of his age. He was born in 1804, was taught in the public schools only; having a taste for painting and engraving, he became a calico-engraver at Lowell and elsewhere; then worked as a portrait-painter for twenty years; took up the making of telescope-lenses in 1846, and, without any other instruction than his own shop afforded, rose to unquestioned pre-eminence in that profession. He was the maker of some of the largest telescopes in the world, including the McCormick telescope at Chicago, the great instruments at Princeton and Washington, the telescope at Pulkowa, Russia, and the Lick telescope, of California.

Spencer F. Baird, head of the Smithsonian Institution and of the United States Fish Commission, died at Wood's Holl, Massachusetts, August 19th, in the sixty-fourth year of his age. He began making a collection of birds when fourteen years old, and contributed papers to the Philadelphia Academy of Sciences while still a youth; was graduated from Dickinson College when seventeen; studied medicine, but did not go into practice; became Professor of Natural History in Dickinson College in 1845; projected a work with Agassiz, which was not completed, on the fresh-water fishes of the United States; was elected Assistant Secretary of the Smithsonian Institution in 1850; was promoted to the head of that institution on the death of Professor Henry; and was appointed Commissioner of Fish and Fisheries in 1871. A list of his works and published contributions in 1882 contained more than one thousand titles.

M. Alfred Terquem, Professor of Physics at Lille, died in Paris, July 17th, in the fifty-seventh year of his age. He was a son of the eminent geologist, Terquem, also deceased.

August Friedrich Pott, who is associated by Professor Max Müller, with Bopp and Grimm, as "the triumvirs who founded the science of comparative philology," died at Halle on the 5th of July, in his eighty-fifth year. He was connected with the University of Halle during his entire active life, and was the author of "Etymologische Forschungen" and of works on the gypsies, on personal names, and on numerals, of essays on mythology, African languages, and general grammar, and of other books and papers.

Sir Walter Elliot, of the Indian Civil Service, who died recently in the eighty-fifth year of his age, was distinguished for his archæological and numismatic researches, and also for his contributions to zoölogy, a large number of which appear in the names of other naturalists, to whom he communicated them. His "Catalogue of the Species of Mammalia found in the Southern Mahratta Country" was a list of the wild animals of the country, many of which were discovered by him. The habits of the larger animals were described from personal observation.

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Bound in what follows

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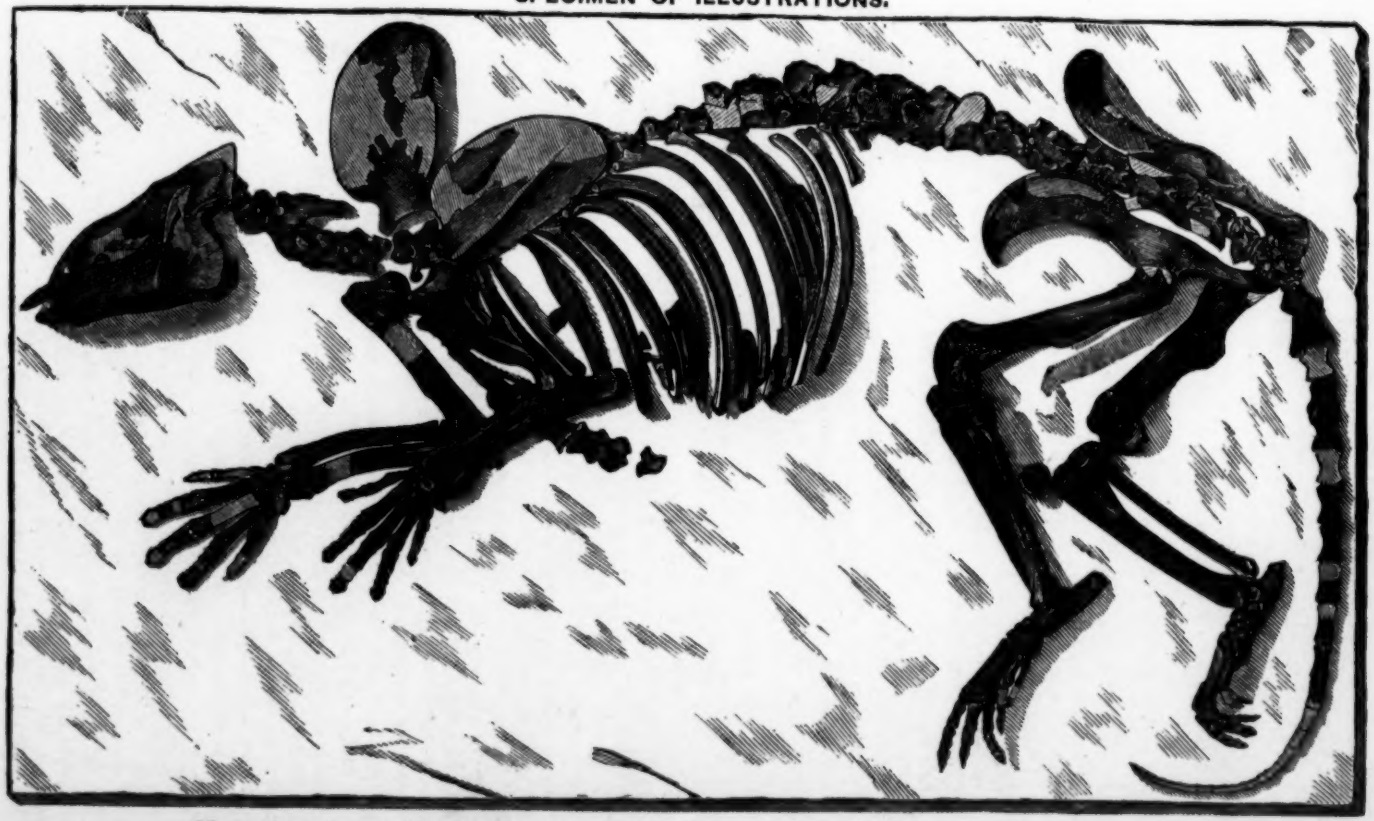
From the Unitarian Review.

"When Darwin's 'Origin of Species' first appeared, instructed writers like Professor Huxley recognized that the general theory of development was not new; while the law of natural selection was Darwin's great contribution to the solution of the question of the *process* of development. His theory was favorably contrasted with that of Lamarck, who found in variations caused by effort or use, among animals, the reason of the transformation of species. It is a very significant sign of the advance of the evolution theory itself that, of later years, an increasing emphasis has come to be laid upon the truth which Lamarck saw, and which Darwin neglected. So that a reversion to a previous type of speculation has taken place, that the main defect of Darwinism itself may be supplied. For, conceding the full validity of natural selection working on variations already in existence, the question still recurs, 'Why or how did these variations come to be there?' 'On this point,' says Professor Cope, 'the Darwinian is on the same footing as the old-time Creationist. The latter says God made the variations, and the Darwinian says that they came by chance. Between these positions, positive science can perceive nothing to choose.'

"How, then, did the fittest *originate?* This is the problem which Professor Cope recurs to Lamarck to answer. The general theory expounded throughout these essays, some of which are technical and others popular or philosophical, is that 'organic structures or species . . . are the result of movements long continued and inherited, and that the character of these movements was originally determined by consciousness or sensibility.' Effort, or use, 'exerted by the living being on its own body,' is the reason why variations occur for natural selection to play on. . . . We regard Professor Cope's work as really tending toward a spiritualistic conception of evolution. As such we esteem it, apart from its more strictly scientific value, as a powerful argument for that 'evolution by the spirit' in which lies the true solution for faith and science of all their differences."

From the Nation.

"While the general doctrine of evolution is nowhere more appreciated than among American naturalists, the same can hardly be said for that particular form of it which is usually known as Darwinism. For many years there has been a tendency among the younger students of Nature—those who have grown up under the influence of the new ideas and the new methods of research which have prevailed since the 'Origin of Species' was published—to be dissatisfied with the doctrine of natural selection as an explanation of the forms, structures, and complex relations of organized beings. While admitting the reality and importance of Darwin's great discovery, they urge that it affords at best but a partial explanation of the facts; that it deals with only half, and that the least important half, of the problem. They maintain that the real essence of the problem is to discover the efficient causes of those 'variations' which are selected, of those 'fittest' modifications of structure which can alone survive; and they believe that the time has come when these great problems may be successfully attacked, and a new light thrown on the inmost recesses of Nature's laboratory.



Phenacodus primævus (*Cope*). *Type believed to be the ancestor of all hoofed mammalia, monkeys, and man.*

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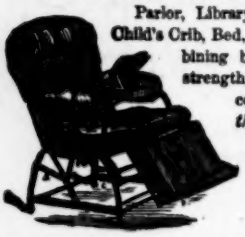

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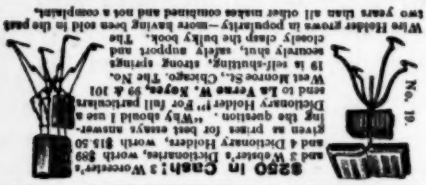

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HOLD this Diagram by the right-hand bottom corner and give it a slight but **rapid** circular twisting motion, *when each circle will separately revolve on its own axis.* The inner cogged wheel will be seen to revolve in an *opposite direction.*

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This paper, heavily charged with an ointment approved by the profession, offers a method of treatment free from the inconvenience and annoyance attending the use of other remedies. The itching type of the disease quickly yields to its influence.

We submit a few extracts from the many letters we receive as to the value of our Medicated Paper. The originals may be seen at our office:

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F. M. JOHNSON, M. D., *July* 1, 1885.

NEW HAVEN, *Feb.* 1, 1886.

It is a decided pleasure to find an advertised article possessing real merit. I inclose $1 for a further supply.

NEW YORK, *April* 5, 1886.

FROM A PHYSICIAN.—I am much pleased with your sample of Medicated Paper. Please send me eight packages and pocket case for $1 inclosed.

NEWBURG, *May* 17, 1886.

My physician recommends your Medicated Paper, and I inclose $1 for eight packets with pocket case.

NEW YORK, *April*, 1885.

Your Medicated Paper has been used with most gratifying result. It is a splendid remedy and has my unqualified indorsement. Please send two 1,000-sheet rolls.

LISBON, D. T., *April* 30, 1886.

Your Medicated Paper is a bonanza in my family; has relieved two cases of long standing. I inclose $1 for two rolls.

NORRISTOWN, PA., *Dec.* 15, 1886.

A. P. W. PAPER CO.

GENTLEMEN:—Having recommended your Medicated Paper to a number of my patients suffering with Hæmorrhoids, I find it of great benefit in preventing the intense itching, and in some cases has made a permanent cure.

NEW HARTFORD, IOWA, *Aug.* 11, 1887.

We can not do without your Medicated Paper. Send $2 worth at once.

PITTSBURG, PA., *Aug.* 7, 1887.

I inclose Postal-Note for four rolls Medicated Paper, the best remedy we have ever found.

CUSTER, IOWA, *Aug.* 8, 1887.

I have tried your Medicated Paper, find it good, and inclose one dollar for further supply.

ARKELE, FINAL CO., ARIZONA, *June* 14, 1887.

Please send me ten rolls of your most excellent Medicated Paper.

GRETNA, IOWA, *Aug.* 1, 1887.

I have suffered for years until relieved by your Medicated Paper. Inclosed find $2 for more of it.

UNIVERSITY, MISS., *July* 8, 1887.

I have had great benefit from your Medicated Paper, and inclose Postal-Note for another roll.

SEDALIA, MO., *July* 15, 1887.

I inclose $1, for which please send me pocket packages of your most excellent Medicated Paper.

DMIOPOLIS, ALA., *July* 29, 1887.

I find your Medicated Paper better than any I have ever used. Send me one dollar's worth in small packages, as I carry it with me.

DENVER, COL., *April* 19, 1887.

I have found your Medicated Paper superior to any I ever saw, and inclose $1 for more of it.

Pocket Packet, $0.10; Price per Roll of 1,000 Sheets securely wrapped in Tin-Foil, $0.50; Eight Packets and Neat Pocket Case, $1.00; Two 1,000-Sheet Rolls, and Nickel Fixture, $1.30.

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To guard alike the large and small
Against the evils that may fall,
Through change of water, food, or air.
Still "NATURE'S REMEDY" we bear.

And should we feel DYSPEPTIC pain,
Or if SICK HEADACHE grips the brain
Or INDIGESTION threaten harm,
Or CONSTIPATION cause alarm,
To neither this or that we'll yield
For TARRANT'S SELTZER is our shield."

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A NATURAL, PALATABLE, RELIABLE REMEDY.

Invaluable for Ladies and Children. Suitable for both sexes and all ages.

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VOL. XXXI.] ESTABLISHED BY EDWARD L. YOUMANS. [No. 6

THE POPULAR SCIENCE MONTHLY.

OCTOBER, 1887.

EDITED BY W. J. YOUMANS.

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CATARRH CURED.

No Falsehood over a Lodge Seal.

This affection of the mucous membrane, wherever located, is a sluggish disease, as any one who remembers the tedious process of getting well over a severe influenza can testify. Hence, the tenacity with which it sometimes resists the action of the best remedial application is truly wonderful.

The results which have followed the treatment of this disease with Compound Oxygen have been of the most gratifying character. Many cases of long standing have been cured, and many more greatly benefited. In addition to reports already made, we offer the following, of recent date:

"ALMA, HARLAN CO., NEB., *March* 15, 1887.

"In November, 1886, I chanced to hear of your Compound Oxygen, and wrote you for your *brochure*. I had spent hundreds of dollars and been swindled by men in all parts of our principal cities. A doctor in Milwaukee, Wis., after getting a description of my disease, informed me my case was not a curable one, and he did not wish to swindle me. Upon receiving your *brochure*, I went to the trouble to write to some of the most prominent men in the United States, whose testimonials were published in it. In every case they wrote me they believed Compound Oxygen, administered by Drs. Starkey & Palen, had saved their lives. Not yet satisfied, I wrote to a Lodge of one of the most prominent secret orders in the world, in Philadelphia, making inquiries. They appointed a committee to investigate. That committee reported that Drs. Starkey & Palen were among the most respectable and prominent business and professional men in the city, and that they had consulted quite a number of their patients in the city, every one of whom declared they owed their lives to Drs. Starkey & Palen, or, rather, to their Treatment of Compound Oxygen. *That settled my mind. I knew brothers would not tell a falsehood under, or rather over, a Lodge Seal.*

"I immediately ordered a Treatment, and commenced inhaling on January 6, 1887. My wife, one of the most devoted of women, who had taken care of me, lifted me, turned me in bed, dressed me and undressed me for ten years, and many of my friends, made light of the Treatment, and I confess it looked to me simplicity doubly refined. But in ten days such was the change in me I could sleep all night, get up in the morning refreshed, and eat breakfast, something I had not done in ten years. I was afflicted with *chronic catarrh*, *diabetes*, and *lower extremities paralyzed from exposure in the army*.

"While I am not entirely cured, diabetes is very much better, nervousness improved, and catarrh in my head is entirely cured. I do unhesitatingly say Compound Oxygen will cure catarrh, and Judge Kelley, of Pennsylvania, who has been in Congress twenty-seven years, continuously, says so too; says it cured him.

"I will state, for the benefit of any person who may see this, that I received a *brochure* from Chicago, Ill., which calls their Oxygen a certain cure for consumption, has a certificate from William Penn Nixon. I notice he states, as he did in a letter to me, that it was 'COMPOUND' Oxygen that cured him. Also received a letter from James Bradford, from our young city, who is a prominent banker, and now our County Treasurer. His wife died the past January, yet she had been using Chicago manufactured Oxygen two years. If there was virtue in it, she was certainly not too far gone to have been cured. Another testimonial they have from Nebraska and one from Portland, which I know to be false, as I am acquainted with the parties.

"I have not had any catarrh, or cold, or hoarseness since I commenced the Treatment; catarrh cured; pass urine about half as often. For three days this week my spine hurt me more than common; I attribute it to disease leaving me. While before using Compound Oxygen I used from two to four teaspoonfuls of laudanum, I now only use one in twenty-four hours, and some days none. My bowels have been for the last ten days regular and healthy, and have not used an enema. As I have several times written to you, I have relied entirely on the Compound Oxygen, to thoroughly give it a test. My wife is thoroughly converted.

"I improved so sensibly I commenced to have my youngest daughter inhale. She was afflicted with *chronic catarrh* of two years' standing, having taken a severe cold while having the measles. She complained of her head, blowing chunks from her nostrils; complained of soreness over her whole body, so much so that she would cry when but slightly squeezed; subject to chills; was so diseased we gravely feared we would not raise her. She will be nine years of age in May, 1887. She could not attend school; nearly every day came home from school sick, often not staying all day. I had tried the most skilled physicians, and other remedies, in the last year, receiving not the least benefit. To-morrow will be two months since she commenced inhaling Compound Oxygen. She is going to school for the last week, blows no lumps from her nostrils, has no chills, complains of no soreness. In truth, she is cured, though we are still having her inhale morning and night, as we believe to make it a permanent cure she had better continue about two weeks longer. I will state, to test the Compound Oxygen, we made no change in her diet; did not give baths; in fact, did nothing, as we were directed to do, except to take the Treatment. She has gained in flesh, cheeks full and of a good, healthy color, is joyous, in good spirits, has regained her appetite; instead of a troubled sleep she sleeps sweetly, gets up refreshed and in a good humor. She said this morning she was going to see what papa had said to those doctors, and she did read it aloud to us and said, 'Well, papa, I guess what you have written is true.'

"(Hon.) H. C. GRIFFITH."

"ALMA, NEB., *April* 6, 1887.

"Doctors, I firmly believe I am going to assume something of my old-time feeling and strength. *I have not lost a good night's sleep in two months, something I had not had before in six years.* What would you or any person value that alone worth? Every one accosts me with, 'How well you are looking! What have you been taking? Have you found a remedy of relief? You look better than for years!' Of course Compound Oxygen then gets a eulogy.

"(Hon.) H. C. GRIFFITH."

"Compound Oxygen—Its Mode of Action and Results," is the title of a new *brochure* of two hundred pages, published by Drs. Starkey & Palen, which gives to all inquirers full information as to this remarkable curative agent, and a record of several hundred surprising cures in a wide range of chronic cases—many of them after being abandoned to die by other physicians—will be mailed free to any address on application. Read the *brochure*, or call and see us.

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BAKER'S

Vanilla Chocolate,

Like all our chocolates, is prepared with the greatest care, and consists of a superior quality of cocoa and sugar, flavored with pure vanilla bean. Served as a drink, or eaten dry as confectionery, it is a delicious article, and is highly recommended by tourists.

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FORTY-SECOND ANNUAL REPORT OF THE

New York Life Ins. Co.

Office, Nos. 346 & 348 BROADWAY, NEW YORK.

JANUARY 1, 1887.

Amount of Net Cash Assets, January 1, 1886.....$63,512,618.00

REVENUE ACCOUNT.

Premiums	$16,386,067.69	
Less deferred premiums, January 1, 1886	878,161.65—	$15,507,906.04
Interest and rents, etc. (including realized gains on Securities sold)	4,157,786.42	
Less Interest accrued January 1, 1886	435,284.18	3,722,502.24—$19,230,408.28

DISBURSEMENT ACCOUNT. $82,743,026.28

Losses by death, including reversionary additions to same		$2,757,085.97
Endowments, matured and discounted, including reversionary additions to same		559,075.01
Dividends, annuities, and purchased policies		4,311,119.11
Total paid Policy-holders	$7,627,280.09	
Taxes and re-insurances		243,142.84
Commissions, brokerages, agency expenses and physicians' fees		2,529,357.57
Office and law expenses, salaries, advertising, printing, etc.		528,672.80—$10,999,402.80

ASSETS. $71,819,623.48

Cash in bank, on hand, and in transit (since received)		$2,065,805.18
United States Bonds and other bonds and stocks (market value, $48,124,273.88)		39,522,443.99
Real Estate		6,580,974.22
Bonds and Mortgage, first lien on real estate (buildings thereon insured for $14,000,000.00, and the policies assigned to the Company as additional collateral security)		15,228,775.00
Temporary Loans (market value of securities held as collateral, $5,912,741.00)		4,450,000.00
*Loans on existing policies (the Reserve held by the Company on these policies amounts to over $2,000,000.00)		408,619.44
*Quarterly and semi-annual premiums on existing policies, due subsequent to Jan. 1, 1887		1,041,666.15
*Premiums on existing policies in course of transmission and collection. (The Reserve on these policies, included in Liabilities, is estimated at $1,050,000)		646,437.14
Agents' balances		161,905.81
Accrued Interest on investments, January 1, 1887		486,497.10—$71,819,623.48
Market value of securities over cost on Company's books		3,601,829.80

*A detailed schedule of these items will accompany the usual annual report filed with the Insurance Department of the State of New York.

CASH ASSETS, January 1, 1887.....$75,421,453.37

APPROPRIATED AS FOLLOWS:

Adjusted losses, due subsequent to January 1, 1887		$202,346.43
Reported losses, awaiting proof, etc.		355,625.28
Matured endowments, due and unpaid (claims not presented)		37,890.70
Annuities due and unpaid (uncalled for)		9,818.74
Reserved for re-insurance on existing policies; participating insurance at 4 per ct. Carlisle net premium; non-participating at 5 per ct. Carlisle net premium.		62,525,599.00
Reserved for contingent liabilities to Tontine Dividend Fund, Jan. 1, 1886, over and above a 4 per cent Reserve on existing policies of that class	$3,123,742.77	
Addition to the Fund during 1886	1,320,530.69	
	$4,444,273.46	
DEDUCT— Returned to Tontine policy-holders during year on matured Tontines,	267,848.21	
Balance of Tontine Fund January 1, 1887		4,176,425.25
Reserved for premiums paid in advance		88,720.72
		$67,340,926.12
Divisible Surplus (Company's Standard)		8,080,527.25
		$75,421,453.37
Surplus by the New York State Standard, at 4½ per cent (including the Tontine Fund)		$16,549,319.53

From the undivided surplus of $8,080,527.25 the Board of Trustees has declared a Reversionary dividend to participating policies in proportion to their contribution to surplus, available on settlement of next annual premium.

Death-claims paid.	Income from Interest.	Insurance in force.	Cash Assets.
1882....$1,955,292.	1882....$2,798,018.	Jan. 1, 1883....$171,415,097.	Jan. 1, 1883....$50,800,396.
1883.... 2,268,092.	1883.... 2,712,863.	Jan. 1, 1884.... 198,746,042.	Jan. 1, 1884.... 55,542,902.
1884.... 2,257,175.	1884.... 2,971,624.	Jan. 1, 1885.... 229,382,586.	Jan. 1, 1885.... 59,283,758.
1885.... 2,999,109.	1885.... 3,399,069.	Jan. 1, 1886.... 259,674,500.	Jan. 1, 1886.... 66,864,321.
1886.... 2,757,035.	1886.... 3,722,502.	Jan. 1, 1887.... 304,373,540.	Jan. 1, 1887.... 75,421,453.

Number of Policies issued during the year, 22,027. Risks assumed, $85,178,294.

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D. O'DELL, Superintendent of Agencies.
A. HUNTINGTON, M. D., Medical Director.

WILLIAM H. BEERS, President.
HENRY TUCK, Vice-President.
ARCHIBALD H. WELCH, 2d Vice-President.
RUFUS W. WEEKS, Actuary.